# Contents

# Chapter 2 Monitoring Data and Water Quality Assessments

Water quality is assessed every two years to fulfill the reporting requirements of Section 303(d) and 305(b) of the Federal Clean Water Act (CWA). To determine how well waterbodies are meeting their best-intended use, chemical, physical and biological parameters are regularly assessed by the DWR. Where enough samples exist, waterbodies are determined to be meeting or exceeding criteria based on a five-year dataset, assigned waterbody classification, and existing water quality standards. Impaired waters are waterbodies where water quality samples are exceeding water quality standards for a particular parameter. Procedures used to evaluate water quality and assign categories are explained in detail in the Integrated Report (IR) methodology. For the purposes of this report, the 2018 methodology was used.

## 2.1 Surface Freshwater Classifications and Water Quality Standards

North Carolina's Water Quality Standards Program adopted classifications and water quality standards for all the states river basins in 1963. The program remains consistent with the Federal Clean Water Act and its amendments. Water quality classifications and standards have also been modified to promote protection of surface water supply watersheds, high quality waters (HQW), and unique and special pristine waters with outstanding resource value (ORW).

### 2.1.1 Statewide Classifications

Surface waters in the state are assigned a primary classification that is appropriate to protect designated best uses of that water. In addition to primary freshwater classifications, surface waters may be assigned one or more supplemental classifications. Most supplemental classifications have been developed to provide special protections to sensitive or high resource waters. Table 2-1 briefly describes the designated best uses of each classification applicable to freshwaters in the Chowan River basin. A full description of classifications is available online through the Classification & Standards Branch website and in the Guide to Freshwater Classifications Chart.

### 2.1.2 Statewide Water Quality Standards

Each primary and supplemental classification is assigned a set of water quality standards that establish the level of water quality that must be maintained in the waterbody to support the uses associated with each classification. Some of the standards outline protective management strategies aimed at controlling point and nonpoint source pollution. The standards for C and SC waters establish the basic protection level for all state surface waters. The other primary and supplemental classifications have more stringent standards than for C and SC, and therefore, require higher level of protection. A full description of water quality standards is available online through the Classification & Standards Branch website.

*Table 2-1 Classifications and Designated Use in the Chowan River Basin*

| **Primary Freshwater Classifications** | |
|---|---|
| **Class** | **Best Uses** |
| **C** | Aquatic life propagation/protection and secondary recreation. |
| **B** | Primary recreation and Class C uses. |
| **Supplemental Classifications** | |
| **NSW** | *Nutrient Sensitive Waters*: Waters subject to excessive plant growth and requiring limitations on nutrient inputs. |

Aquatic Life Propagation and Secondary Recreation (Class C)

The aquatic life/secondary recreation use support category is applied to all waters in NC. Therefore, this category is applied to the 796 stream miles in the Chowan River basin.

Primary Recreation (Class B)

There are 99 miles currently classified for primary recreation in the Chowan River. Waters classified as Class B are protected for primary recreation, include frequent or organized swimming, and must meet water quality standards for fecal coliform bacteria. Sewage and all discharged wastes into Class B waters must be treated to avoid potential impacts to the existing water quality.

Nutrient Sensitive Waters (Class NSW)

Nutrient sensitive water (NSW) is a supplemental classification that the Environmental Management Commission (EMC) may apply to surface waters that are experiencing or are subject to growths of microscopic or macroscopic vegetation. In 1979, all waters of the Chowan River basin were designated as NSW. The Chowan River basin was the first waterbody in the state to receive the supplemental classification because of water quality problems associated with nutrient enrichment. In response to nuisance algal blooms and fish kills in North Carolina's waters, the EMC established the NSW supplemental classification in May 1979 as a legal basis for controlling the discharge of nutrients, primarily nitrogen and phosphorus, into surface waters. This classification took effect in September 1979 for the Chowan River; thereby, enabling nutrient limits to be included in the NPDES permits of wastewater treatment plants that discharge in the river basin.

## 2.2 Interpreting Data

In NC, criteria are established to protect the surface water classification, or designation, of a waterbody. The criteria define the maximum pollutant concentrations, goals, conditions or other requirements in order for a waterbody to maintain or attain its designation. In the Chowan River basin, water quality was assessed for aquatic life, recreation, and fish consumption on a monitored or evaluated basis. Waters are assessed based on the parameter of interest and are found to be:

- Meeting Criteria (meeting standards)
- Exceeding Criteria (exceeding standards, also referred to as impaired)
- Data Inconclusive (data does not allow for an assessment to be made)

Biological (benthic and fish community) samples are given a bioclassification based on the data collected at the site by DWR biologists in the Water Sciences Section (WSS) [Biological Assessment Branch (BAB).](#) Different benthic macroinvertebrate criteria have been developed for different ecoregions (mountains, piedmont, coastal plain, and swamp). They include measurements for diversity, abundance and the number of pollution tolerant or intolerant species found within a particular waterbody. Most wadeable, flowing stream sites are assigned a bioclassification of Excellent, Good, Good-Fair, Not Impaired, Not Rated, Fair or Poor. Swamp stream bioclassification fall into three categories: Natural, Moderate and Severe.

Ambient monitoring data are analyzed based on the percent of samples exceeding the state standard for individual parameters for each site within a five-year period. In general, if more than 10% of the samples exceed the standard for a water quality parameter with 90% statistical confidence, the stream segment is Exceeding Criteria, or impaired, for that parameter. The standard for fecal coliform bacteria (FCB) is the exception to the rule as it relies of a 5-in-30 sampling regime which is the collection of 5 samples within a 30-day period.

Each biological parameter (benthic and fish) and each ambient parameter is assessed independently and assigned a category based on its rating or percent exceedance. Each monitored stream segment is given an overall category number. Table 2-2 illustrates how bioclassifications for biological samples and ambient data are translated into categories. For example, if the ambient data is meeting criteria for all parameters but the bioclassification is exceeding the criteria established for fish, the waterbody will be assigned to Category 5 for fish community.

Category 4 is assigned when a parameter is exceeding criteria, but (1) the development of a Total Maximum Daily Load (TMDL) is not required, (2) a TMDL or management strategy is already in place, and/or (3) a variance is in place. The development of a TMDL includes a study of the watershed to identify the sources of the pollutant of interest, calculations and modeling to identify the pollutant contributions, and reductions needed from point and nonpoint sources of pollution. Category 5 is assigned when a parameter is exceeding criteria, and a TMDL is required. Category 5 assessments are the 303(d) list, which has historically been referred to as the impaired waters list. More detailed information about each category can be found in the IR methodology.

*Table 2-2 Water Quality Assessments and Categories (2016)*

| Biological Ratings (Bioclassifications) | Water Quality Assessment (EPA Categories) | Ambient Monitoring Data |
|---|---|---|
| Excellent/Natural | Meeting Criteria (Categories 1 and 2) | Numerical standard exceeded in ≤ 10% of the samples collected |
| Good | | |
| Good-Fair/Moderate | | |
| Not Impaired | | |
| Not Rated | Data Inconclusive (Category 3) | Less than 10 samples were collected |
| Fair | Exceeding Criteria (Categories 4 and 5) | Numerical standard exceeded in ≥ 10% of samples collected with a 90% confidence in exceedance |
| Poor/Severe | | |

## 2.3 Benthic Macroinvertebrate Monitoring Data

Benthic macroinvertebrate communities are composed of aquatic insects and crustacean species such as crayfish, mollusk-like mussels, clams, and snails, and aquatic worms. Aquatic benthic species are useful for biological monitoring as they are found in all aquatic environments and are less mobile than many other groups of organisms and are easily collectable. Aquatic benthic communities respond to a wide array of potential pollutants. The sedentary nature of benthic macroinvertebrates also ensures that exposure to a pollutant or stress in the environment accurately shows local conditions and allows for the comparison of sites, even within near proximity of each other. BAB biologists incorporated species richness, abundance, composition, and pollution indicator species into the benthic biocriteria used to calculate Index of Biological Integrity (IBI) scores and bioclassification ratings. Certain species of benthos, like mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera), referred to in combination as EPT, are typically highly sensitive to pollution and their presence or absence can be an indicator of water quality condition. EPT species presence has been incorporated into the biocriteria and is used to evaluate some monitoring sites. As previously mentioned, biocriteria (i.e. the methods used to calculate the IBI score), bioclassification assignment, and sampling methodology can vary with region and stream condition. The Chowan River basin is monitored using primarily two types of stream collection methods Swamp and Coastal B (boat).

Swamp streams are classified by BAB as streams within the coastal plain ecoregion with little to no visible flow during certain parts of the year. Little or no flow usually occurs during summer months, but flowing water should be present in swamp streams during winter months. Samples are collected during winter months (February to early March) because sampling during the high-flow months provides the best opportunity for detecting differences in naturally occurring communities. Swamp stream bioclassification fall into three categories: Natural, Moderate and Severe, but swamp streams will receive a Not Rated bioclassification if the pH value is 4.0 or lower; even those below 4.5 are difficult to evaluate.

Coastal B rivers are defined as waters in the coastal plain that are deep (non-wadeable), freshwater systems with little or no visible current under normal or low flow conditions. Other characteristics may include an open canopy, low pH and low dissolved oxygen. There currently is not an approved biocriteria for these Coastal B streams, and therefore a bioclassification of Not Rated is assigned to these sites. For specific methodology defining how these ratings are given, refer to the Benthic Standard Operating Procedures (SOP).

Waterbodies, also known as assessment units (AUs), that have Excellent, Good, Natural or Moderate bioclassification ratings will consistently contain diverse, stable, and pollution-sensitive communities of aquatic benthic macroinvertebrates. A total of 12 benthic sites were sampled during the 2010 cycle and 9 sites were sampled during the 2015 cycle. Three additional sites were sampled as part of special studies. Two sites were sampled in 2011 as part of a special study requested by the Raleigh Regional Office (RRO). Staff from the regional office were investigating the possible effects on surface water from runoff associated with a mulching operation. One site was sampled in 2012 as part of the 106-grant funded monitoring work. More specific information about the special studies can be found in Chapters 3 and 4. Figure 2-1 shows the location and bioclassification of the most recent sampling event. Table 2-3 lists the most recent basinwide and special study sites and includes previous ratings for sites where multiple samples were collected. Figure 2-2 provides a graphic representation of the percentage of sites that had a bioclassification change, were not resampled, or are new stations within the basin. Table 2-3 also includes the bioclassification by sampling methodology and year. Numerous sites sampled during the 2005 basinwide cycle were not resampled in 2010 basinwide cycle. Additionally, many stations were not assessed in 2015 due to reductions in staff. Most of the sites sampled rated Moderate bioclassification with only one site receiving Not Rated in 2015. Chinkapin Swamp (DB3) was the only site that declined in bioclassification rating and the Chowan River (DB14) declined based on provisional bioclassification criteria. This provision criterion is for non-wadeable stream which require sampling by boat.

*Figure 2-1 Benthic Macroinvertebrate Sampling Sites (2010-2015)*

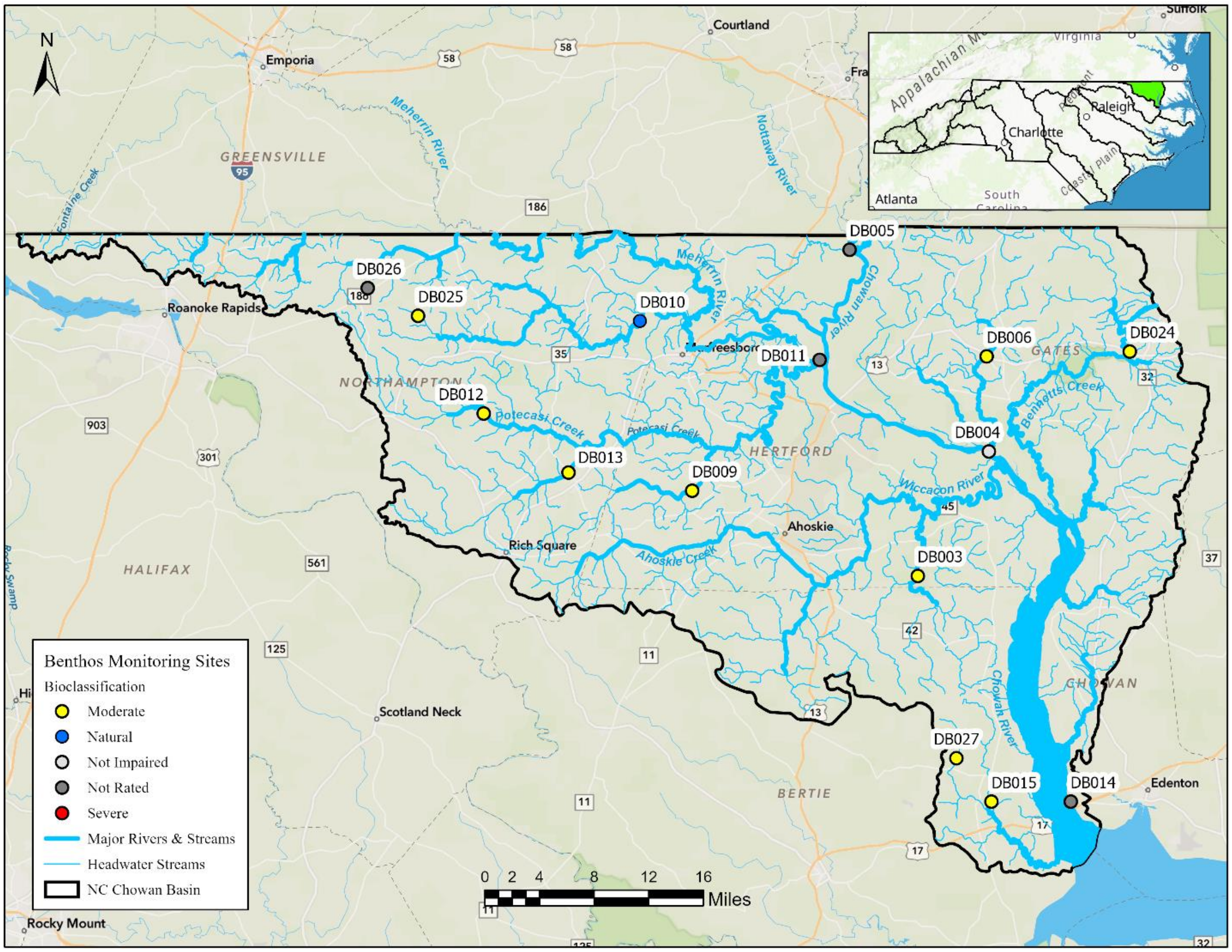



*Table 2-3 Biological Monitoring Data Results – Benthic Macroinvertebrates*

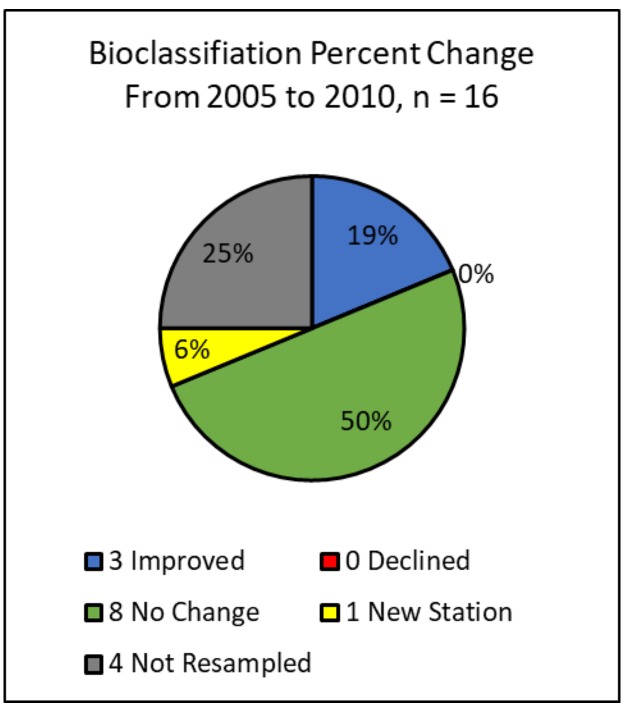
| Station ID | Waterbody Name | Assessment Unit # | Drainage Area ($mi^2$) | Assessment Method | Sampling Date | Bioclassification |
|---|---|---|---|---|---|---|
| DB11 | Meherrin River | 25-4-(5) | 1610 | Boat | 7/31/2000 | Good |
| | | | | | 9/27/2005 | Good-Fair |
| | | | | | 7/21/2010 | Not Impaired |
| | | | | | 7/11/2015 | Not Rated |

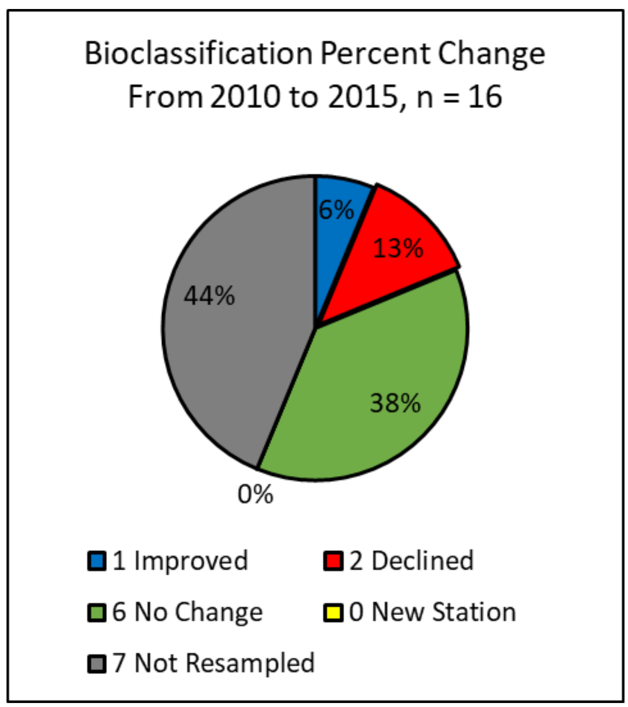
| Station ID | Waterbody Name | Assessment Unit # | Drainage Area (mi$^2$) | Assessment Method | Sampling Date | Bioclassification |
|---|---|---|---|---|---|---|
| DB10 | Kirbys Creek | 25-4-4 | 61.5 | Swamp | 2/17/2000 | Natural |
| | | | | | 2/7/2005 | Moderate |
| | | | | | 2/25/2010 | Natural |
| | | | | | 2/3/2015 | Natural |
| DB12 | Potecasi Creek | 25-4-8a | 31.8 | Swamp | 2/9/2000 | Moderate |
| | | | | | 2/7/2005 | Moderate |
| | | | | | 2/23/2010 | Moderate |
| | | | | | 2/4/2015 | Moderate |
| DB13 | Urahaw Swamp | 25-4-8-4 | 54.9 | Swamp | 2/9/2000 | Moderate |
| | | | | | 2/7/2005 | Moderate |
| | | | | | 2/23/2010 | Moderate |
| | | | | | 2/4/2015 | Moderate |
| DB9 | Cutawhiskie Creek | 25-4-8-8 | 36.4 | Swamp | 2/2/2000 | Not Rated |
| | | | | Swamp | 2/8/2005 | Not Rated |
| | | | | Full Scale | 8/26/2005 | Not Rated |
| | | | | Swamp | 2/24/2010 | Moderate |
| DB26* | Ivy Creek | 25-4-3-1 | 1 | Swamp | 3/14/2011 | Not Rated |
| DB25* | Unnamed Tributary Corduroy Swamp | 25-4-4-1ut8 | 1.1 | Swamp | 3/14/2011 | Moderate |
| DB5 | Chowan River | 25a1 | 2470 | Boat | 7/31/2000 | Good-Fair |
| | | | | | 9/28/2005 | Good |
| | | | | | 7/21/2010 | Not Impaired |
| | | | | | 7/11/2015 | Not Rated |
| DB4 | Chowan River | 25a2b | 4350 | Boat | 8/1/2000 | Good |
| | | | | | 9/27/2005 | Fair |
| | | | | | 7/23/2010 | Not Impaired |
| DB6 | Cole Creek | 25-12-7 | 32.1 | Swamp | 2/10/2000 | Moderate |
| | | | | | 2/8/2005 | Moderate |
| | | | | | 2/24/2010 | Moderate |
| | | | | | 2/3/2015 | Moderate |
| DB1 | Ahoskie Creek | 25-14-1 | 135.1 | Swamp | 2/9/2005 | Not Rated |
| | | | | Full Scale | 8/25/2005 | Not Rated |
| DB7 | Stony Creek | 14-1-6 | 59.8 | Swamp | 2/10/2000 | Moderate |
| | | | | | 2/10/2005 | Moderate |
| DB8 | Wiccacon River | 25-14 | 265 | Boat | 8/1/2000 | Fair |
| | | | | | 8/22/2005 | Fair |

| Station ID | Waterbody Name | Assessment Unit # | Drainage Area ($mi^2$) | Assessment Method | Sampling Date | Bioclassification |
|---|---|---|---|---|---|---|
| DB3 | Chinkapin Swamp | 25-14-3 | 50 | Swamp | 2/10/2000 | Natural |
| | | | | | 2/10/2005 | Natural |
| | | | | | 2/25/2010 | Natural |
| | | | | | 2/2/2015 | Moderate |
| DB24 | Duke Swamp | 25-17-1 | 42.7 | Swamp | 2/24/2010 | Moderate |
| DB2 | Bennetts Creek | 25-17 | 83 | Swamp | 2/9/2005 | Moderate |
| DB14 | Chowan River | 25c | 4920 | Boat | 8/1/2000 | Good-Fair |
| | | | | | 8/22/2005 | Good |
| | | | | | 7/20/2010 | Not Impaired |
| | | | | | 7/11/2015 | Not Rated |
| DB15 | Eastmost Swamp | 25-24-1 | 13.3 | Swamp | 2/22/2000 | Moderate |
| | | | | | 2/10/2005 | Moderate |
| | | | | | 2/25/2010 | Moderate |
| | | | | | 2/2/2015 | Moderate |
| DB27* | Cricket Swamp | 25-24-2 | 4 | Swamp | 3/6/2012 | Moderate |

*Special Study monitoring not part of 5-year Basin Cycle Monitoring

*Figure 2-2 Percent Change in Benthic Macroinvertebrate Bioclassification between 2005 and 2015. Not Rated or Not Impaired Bioclassifications Were Replaced with Inter-Year Comparison Bioclassifications.*



## 2.4 Fish Kill Assessment

DWR has systematically monitored and reported fish kill events across the state since 1996. Field reports between 2005 and 2018 have generally shown light fish kill activity (two or less events) in the Chowan River basin each year. Low dissolved oxygen levels resulting from Hurricane Irene in 2011 and shallow waters with high temperatures may have contributed to these fish kill events. In 2019, multiple citizen reports indicate greater than two fish kills occurred in the Chowan River.

The WSS has a Fish Kill Reporting Application available to the public using your phone, tablet or PC and a map located on the WSS website. WSS and the NCDEQ Regional Offices work together to check and verify the citizen reported fish kills as resources and safety allow. Fish kill reports were have been drafted through 2019 which include Citizen Reports and DWR Fish Kill Reports (2019 Report) and going forward DWR will be referring the public to a website dashboard which will be available soon. Information on how to report a fish kill, recent fish kill activity, and annual fish kill reports can be found on DWR's WSS website.

## 2.5 Fish Communities

Fish Communities use the North Carolina Index of Biological Integrity (NCIBI) which incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities such as water quality, energy source, habitat quality, flow regime, and biotic interactions. The index is undergoing revisions for the Upper Coastal Plain (Chowan, Neuse, Pasquotank, Roanoke, Tar, and White Oak River basins) as such the fish community sites in the Chowan River basin have not been sampled since 2000. Fish community sites and standard operating procedures can be found on the WSS Biological Assessment Branch Fish Communities Assessment and Fish Tissue websites.

## 2.6 Ambient Data

The Ambient Monitoring System (AMS) is a network of stream, lake and estuarine stations strategically located for the collection of physical and chemical water quality data. North Carolina has approximately 329 active AMS stations. Parameters collected at each site depend on the waterbody's classification but typically include specific conductance, dissolved oxygen, pH, temperature, turbidity, nutrients, and fecal coliform. Each stream classification has an associated set of standards the parameters must meet to be considered supporting the waterbody's designated uses. Ten sample results are required within the five-year data collection window to evaluate the water quality parameter and compare it to the water quality standards.

Chemical and physical parameters were obtained by DWR from nine stations located throughout the Chowan River Basin. Of the nine stations currently operating in the Chowan River basin, five are located on the mainstem of the Chowan River in North Carolina and one site is in VA on the Nottoway River approximately three miles before the confluence with the Blackwater River (at which point they become the Chowan River) (Figure 2-3 and Table 2-4). The Blackwater River in VA is also monitored by one AMS station. Lastly, one AMS station is located on Potecasi Creek and one is located on the Meherrin River.

In addition, three stations were monitored between 2009-2014 as part of the Random Ambient Monitoring System (RAMS). RAMS is a component of the AMS and is a probabilistic monitoring initiative in which sampling locations are randomly selected and located on freshwater streams throughout the basin (Figure 2-3 and Table 2-4). The stations are sampled once a month for two years and then "retired."

RAMS focuses on smaller streams and allows the division to collect data on water quality parameters that are not evaluated through AMS and allows the division to answer broad questions about water quality in North Carolina's smaller streams. Parameters collected through RAMS that are not collected through AMS include: chloride, fluoride, sulfate, dissolved organic carbon, metals, mercury, and volatile organic compounds. Every site is scheduled to be visited once per month for the duration of the two years of monitoring totaling 24 sampling events.

Most of the water quality standards are being met at the AMS stations sampled within the Chowan River Basin. Cricket Swamp (Assessment Unit: 25-24-2) is on the 303(d) list or impaired waters list due low pH. Cricket Swamp was sampled as part of RAMS (D9515000) during the 2011-2012 sampling period. The upper Chowan River (Assessment Unit: 25a2b) segment, has been on the impaired waters list since 2002 for exceeding the Cadmium (2 µg/l, Aquatic Life, Fresh Water) standard at ambient monitoring station D6250000, but was removed or delisted in the 2018 assessment based on the approved dissolved metals water quality standards for North Carolina approved by the EPA on April 2016. The Wiccacon River (Assessment Unit: 25-14) has remained on the impaired waters list since 1998 due to biological impairment.

*Figure 2-3* Ambient Monitoring Stations (2000-2019)

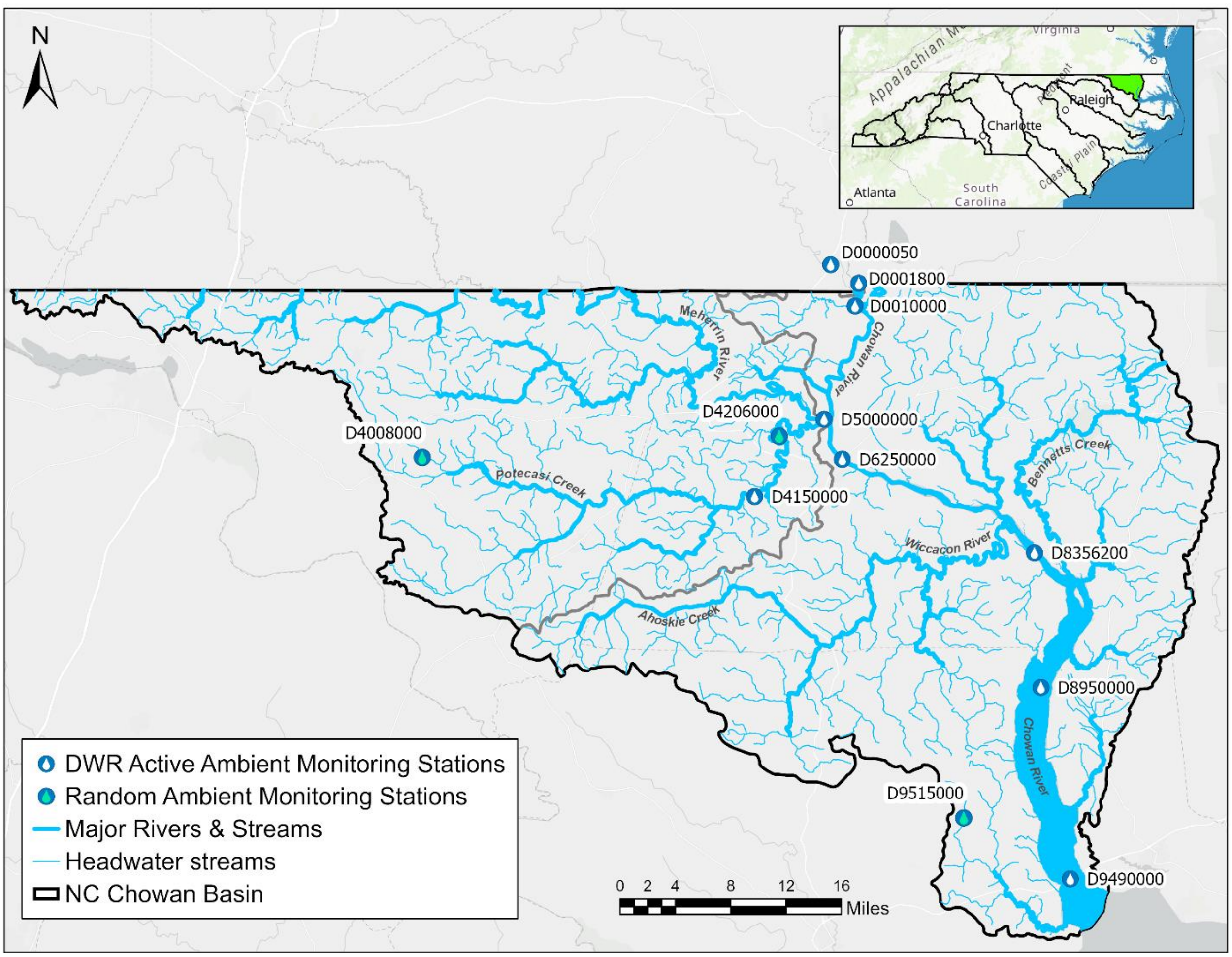


*Table 2-4 DWR Ambient and Random Ambient Monitoring Stations in the Chowan River Basin, 2005 - 2019*

| Station ID | Station Location | Active Date | County | State | Stream Classification |
|---|---|---|---|---|---|
| Ambient Monitoring Sites | | | | | |
| D0000050 | NOTTOWAY RIVER AT US 258 NEAR RIVERDALE VA | 1/1981-Present | SOUTHAMPTON | VA | II Estuarine |
| D0001800 | BLACKWATER RIVER .5 MI UPS MOUTH NEAR WYANOKE | 1/1981-Present | GATES | VA | B NSW |
| D0010000 | CHOWAN RIVER NEAR RIDDICKSVILLE | 3/1974-Present | HERTFORD | NC | B NSW |
| D4150000 | POTECASI CREEK AT NC 11 NEAR UNION | 1/1981-10/2019 | HERTFORD | NC | C NSW |
| D4151000 | POTECASI CREEK NEAR SR1108 | 10/2019-Present | HERTFORD | NC | C NSW |
| D5000000 | MEHERRIN RIVER AT SECONDARY ROAD 1175 PARKERS FERRY NEAR COMO | 1/1974-Present | HERTFORD | NC | B NSW |
| D6250000 | CHOWAN RIVER AT US 13 AT WINTON | 4/1969-Present | HERTFORD | NC | B NSW |
| D8356200 | CHOWAN RIVER AT CHANNEL MARKER 16 NEAR GATESVILLE | 1/1981-Present | GATES | NC | B NSW |
| D8950000 | CHOWAN RIVER AT CHANNEL MARKER 7 AT COLERAIN | 5/1969-Present | CHOWAN | NC | B NSW |
| D9490000 | CHOWAN RIVER AT US 17 AT EDENHOUSE | 5/1969-Present | BERTIE | NC | B NSW |
| Random Ambient Monitoring Sites | | | | | |
| D4008000 | WICCACANEE SWAMP AT SR 1500 NEAR JACKSON | 1/2009-12/2010 | NORTHAMPTON | NC | C NSW |
| D9515000 | CRICKET SWAMP OFF SECONDARY RAOD 1346 NEAR ASHLAND | 1/2011-12/2012 | BERTIE | NC | C NSW |
| D4206000 | POTECASI CREEK OFF NC 158 NEAR MAPLETON | 1/2013-12/2014 | HERTFORD | NC | C NSW |

### 2.6.1 Turbidity

The turbidity standard for freshwater streams is 50 NTUs. Turbidity is a measure of cloudiness in water and is often accompanied with excessive sediment deposits in the streambed. Excessive sediment deposited on stream and lake bottoms can choke spawning beds (reducing fish survival and growth rates), harm fish food sources, fill in pools (reducing cover from prey and high temperature refuges), and reduce habitat complexity in stream channels. Excessive suspended sediments can also make it difficult for fish to find prey and at high levels can cause direct physical harm, such as clogged gills. Sediments can also cause taste and odor problems, block water supply intakes, foul treatment systems, and fill reservoirs. Soil erosion is the most common source of turbidity. Some erosion is a natural phenomenon, but human actions and land use practices can accelerate the process to unhealthy levels. Construction sites, mining operations, agricultural operations, logging operations, and excessive stormwater flow off of impervious surfaces are all potential sources of erosion and turbidity in a stream channel.

The annual mean turbidity readings in the Blackwater (D0001800), Nottoway (D0000050), and Chowan (D0010000) rivers are relatively low and do not violate the water quality standard. The Nottoway River displayed a dominant influence on the turbidity levels in upper section of the Chowan River (Figure 2-4). Annual mean turbidity occurring in the stations downstream from where the Chowan River forms (D6250000) displayed consistently higher turbidity levels relative to upstream stations (Figure 2-5). This could be the result of mixing with water from Potecasi Creek (D4150000) which has elevated turbidity levels relative to the Meherrin River (Figure 2-6). Peak annual mean turbidity levels have been observed at the two lowermost stations in the Chowan River (D8950000 and D9490000) between 2014 through 2018 (Figure 2-5). During this most recent period of monitoring at these two stations, only one measurement exceeded the turbidity standard of 50 NTUs on 6/22/2017 at station D8950000. Comparing these two downstream stations to the closest upstream station (D8356200) indicates these elevated turbidity levels could be the result human activity, land use practices, and/or algal growth in the areas around Bennetts Creek, Catherine Creek, Keel Creek, Indian Creek, Rockyhock Creek and/or other tributaries.

*Figure 2-4 Annual Weighted Mean Turbidity Readings from the Nottoway (D0000050), Blackwater (D0001800) and Chowan (D0010000) Rivers with the Discharge from the Nottoway River (USGS Gage 02047000).*

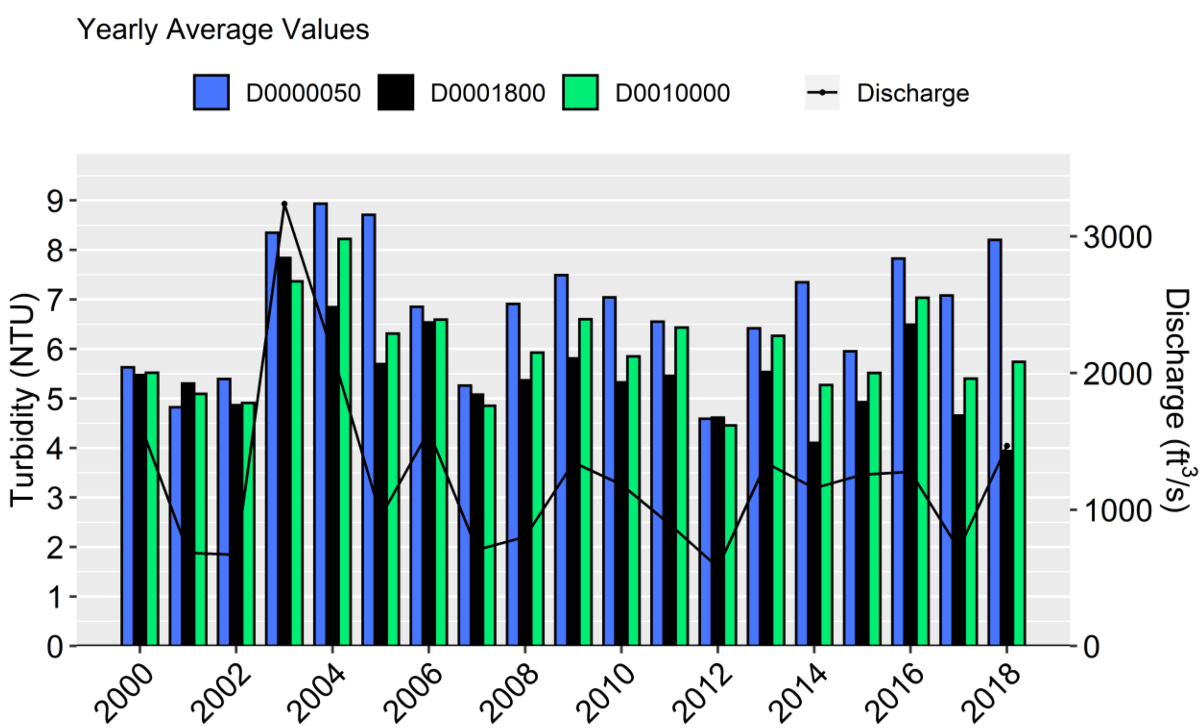


*Figure 2-5 Annual Weighted Mean Turbidity Readings from the Mainstem Chowan River Stations with the Discharge from the Nottoway River (USGS Gage 02047000).*

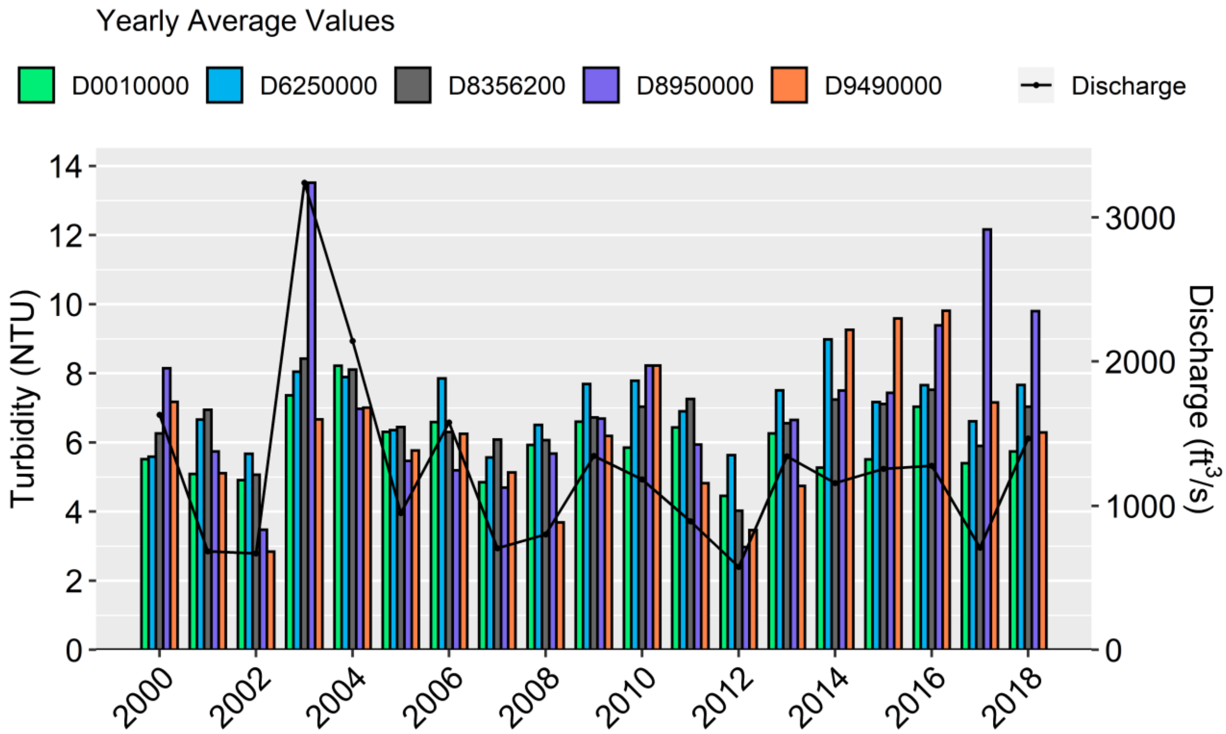
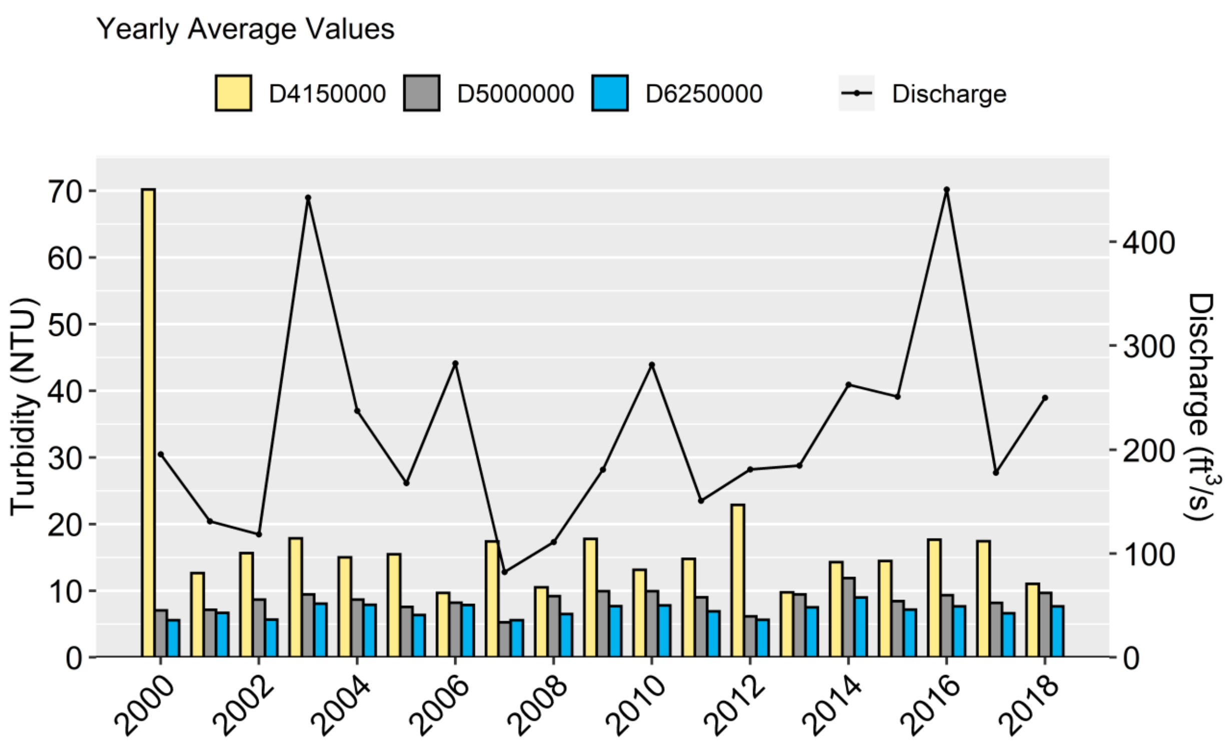



*Figure 2-6 Annual Weighted Mean Turbidity Readings from Potecasi Creek (D4150000), Meherrin River (D5000000), Chowan River (D6250000) with the Discharge from the Potecasi Creek (USGS Gage 02053200).*



### 2.6.2 pH

The water quality standard for pH in freshwater is 6.0 to 9.0 standard units. It is the measure of hydrogen ion concentration that is used to express whether a solution is acidic or alkaline (basic). Low values (< 6.0) can be found in waters rich in dissolved organic matter, such as swamp lands, whereas high values (> 9.0) may be found during algal blooms. Lower values can have chronic effects on the community structure of macroinvertebrates, fish, and phytoplankton.

The annual median pH readings in the Blackwater (D0001800), Nottoway (D0000050) and Chowan (D0010000) Rivers are relatively similar (Figure 2-7). Annual median pH levels in the station downstream from where the Chowan River forms (D6250000) displayed a shift from higher annual median pH levels between 2000 and 2010 to consistently lower pH levels between 2010 and 2018 (Figure 2-8). This shift corresponds with the larger differences observed in annual median pH levels between Potecasi Creek (D4150000) and the Meherrin River (D5000000) (Figure 2-9). This could indicate a shift in Potecasi Creek, resulting in a lowering of the pH in Potecasi Creek that then influences the Chowan River monitored by station D6250000. As the annual median pH levels in the Chowan River are observed going downstream, the pH levels increase with peak annual median values fluctuating between the two lowermost station (D8950000 and D9490000) (Figure 2-8).

*Figure 2-7 Annual Median pH Readings from the Nottoway (D0000050), Blackwater (D0001800) and Chowan (D0010000) Rivers with the Discharge from the Nottoway River (USGS Gage 02047000).*

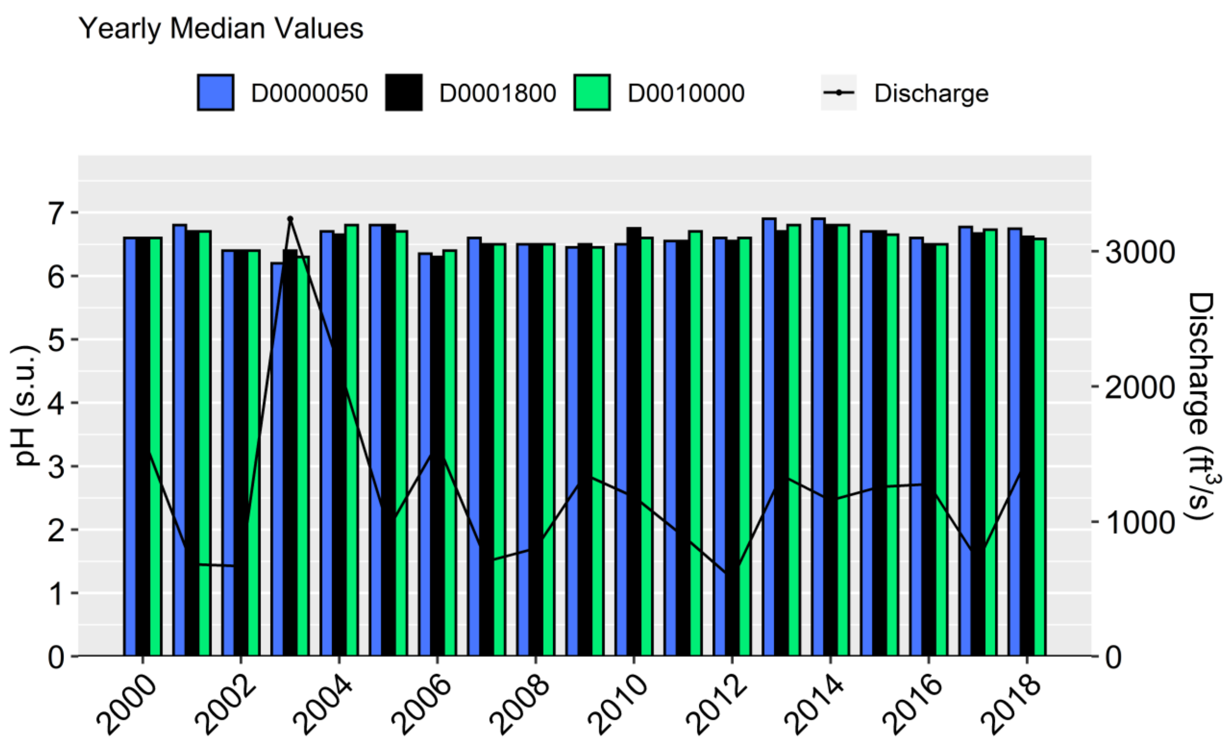


*Figure 2-8 Annual Median pH Readings from the Mainstem Chowan River Stations with the Discharge from the Nottoway River (USGS Gage 02047000).*

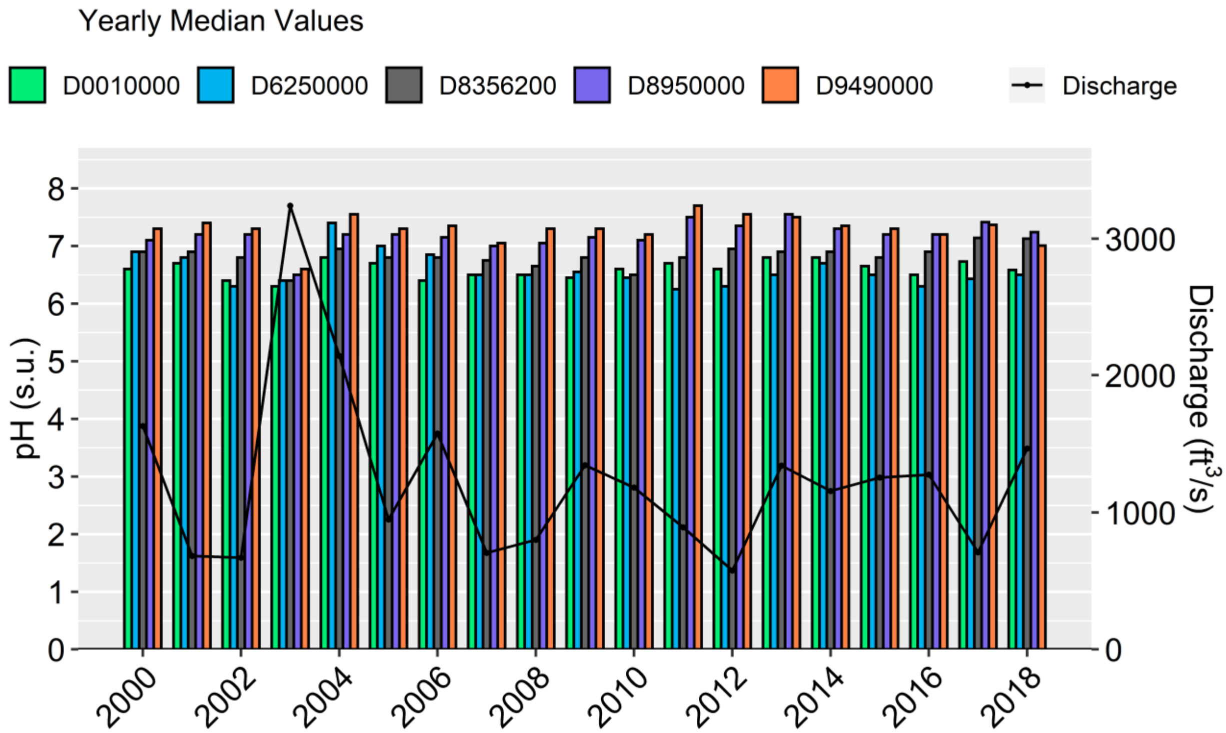
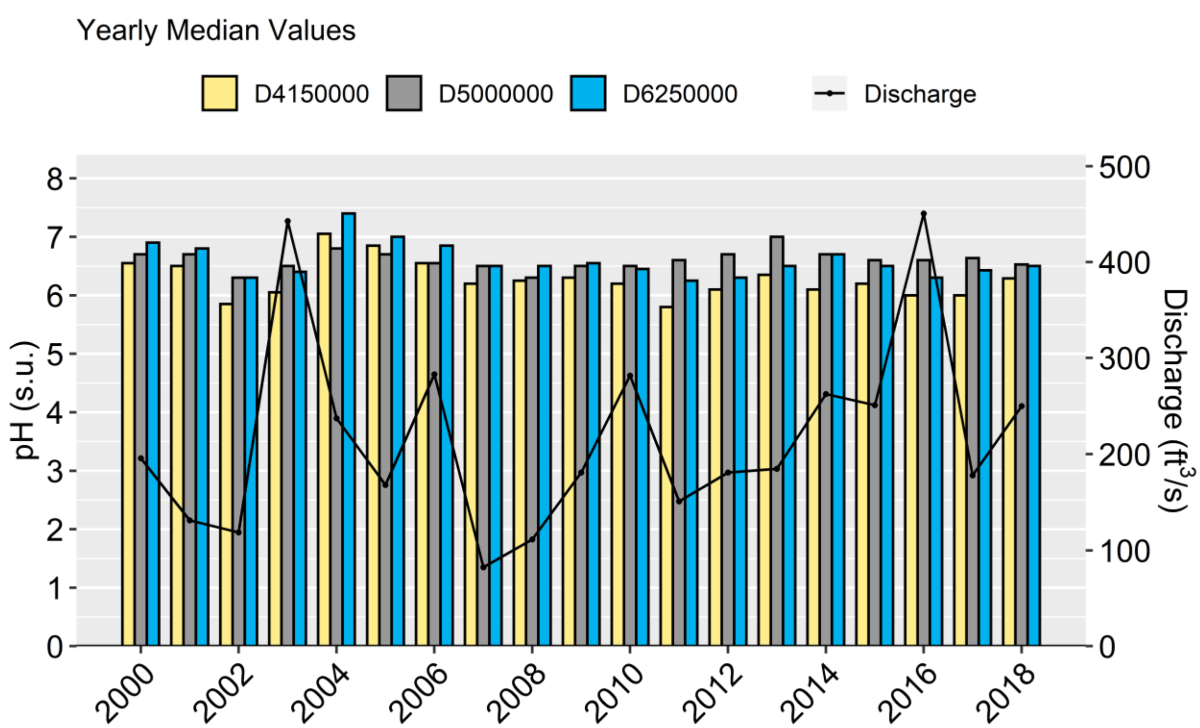



*Figure 2-9 Annual Median pH Readings from Potecasi Creek (D4150000), Meherrin River (D5000000), Chowan River (D6250000) with the Discharge from the Potecasi Creek (USGS Gage 02053200).*



### 2.6.3 Dissolved Oxygen

The dissolved oxygen (DO) water quality standard for freshwater is not less than a daily average of 5 mg/L or a minimum instantaneous value of not less than 4 mg/L. DO levels are often the product of wind or wave action mixing air into the water. It is also a produced through aquatic plant photosynthesis. During the day, DO levels are higher when photosynthesis occurs. Levels drop at night with aquatic organism respiration. High DO levels are often found in cool, swift moving waters. Low levels are found in warm, slow moving waters. In slow moving waters, such as reservoirs, depth is also a factor. Wind action and plants can cause these waters to have a higher DO concentration near the surface, while biochemical reactions lower in the water column may result in DO concentrations as low as zero.

The Nottoway and the Blackwater originate in VA then come together to form the Chowan River at the NC/VA state line. These two VA rivers are on the impaired waters list for DO impairments, although the Blackwater River was determined to be impaired due to natural conditions. The low DO concentrations observed in the Blackwater River (D0001800), relative to the Nottoway River (D0000050), influence the Chowan River (D0010000) (Figure 2-10 and Figure 2-13). The Chowan River has relatively low DO conditions in the upper reaches (D0010000 and D6250000), but the DO concentrations progressively increase as the Chowan River is observed from where it forms to the furthest downstream station at Edenhouse (D9490000) (Figure 2-11; Figure 2-13 through Figure 2-17). The annual mean DO concentrations from the Meherrin River (D5000000) and Potecasi Creek (D4150000) are relatively similar to the nearby mainstem Chowan River station (D6250000) with neither stream displaying a dominant influence on the Chowan River (Figure 2-12).

*Figure 2-10 Annual Weighted Mean Dissolved Oxygen Readings from the Blackwater (D0001800), Nottoway (D0000050) and Chowan (D0010000) Rivers with the Discharge from the Nottoway River (USGS Gage 02047000).*

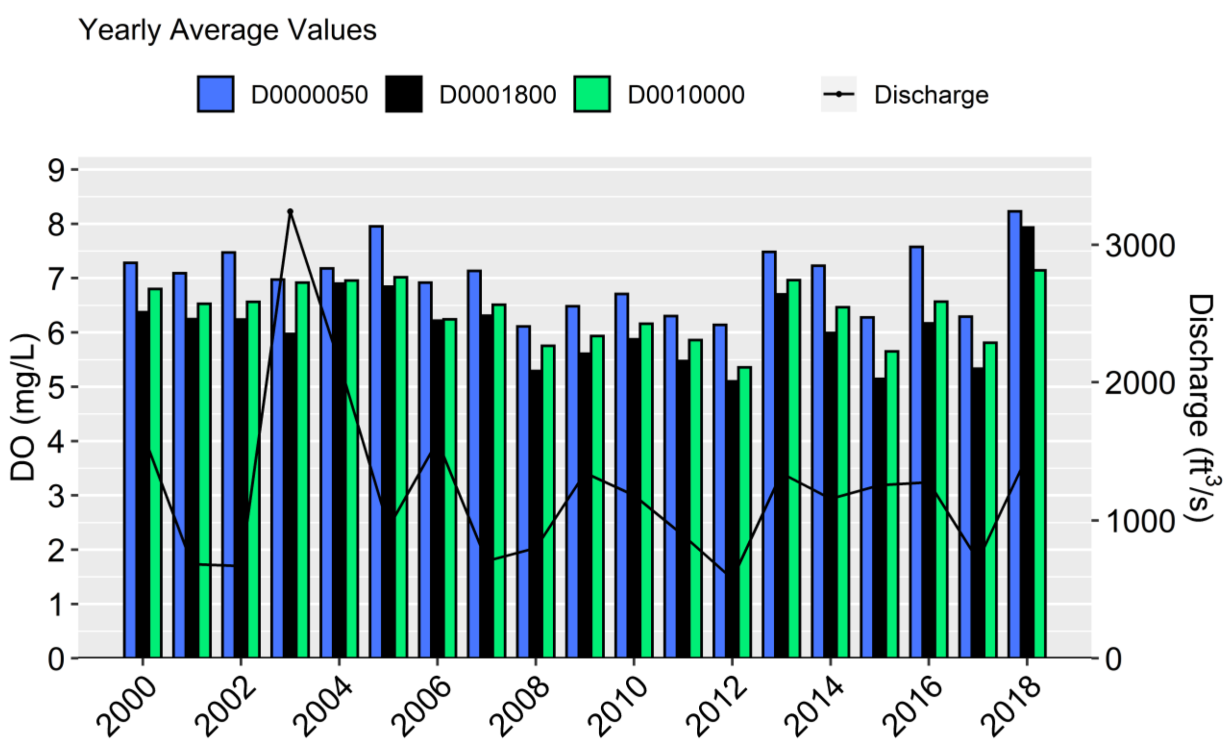


*Figure 2-11 Annual Weighted Mean Dissolved Oxygen Readings from the Mainstem Chowan River Stations with the Discharge from the Nottoway River (USGS Gage 02047000).*

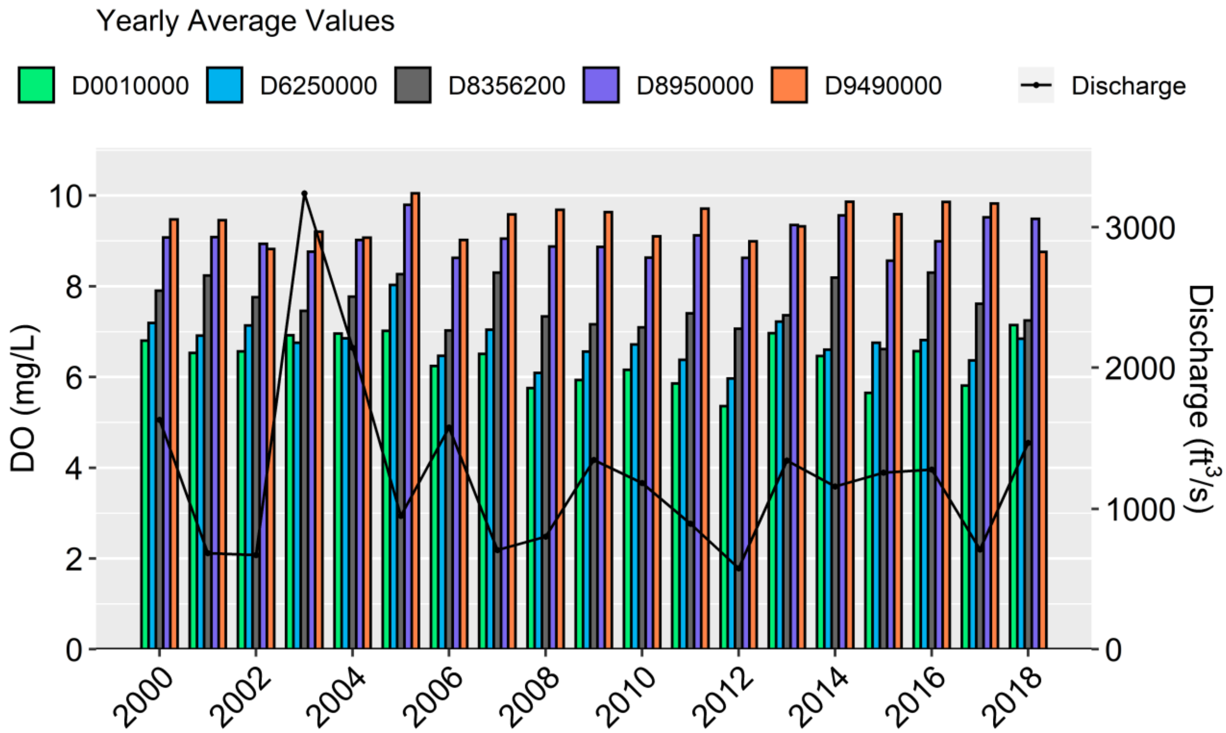



*Figure 2-12 Annual Weighted Mean Dissolved Oxygen Readings from Potecasi Creek (D4150000), Meherrin River (D5000000), Chowan River (D6250000) with the from the Potecasi Creek (USGS Gage 02053200).*

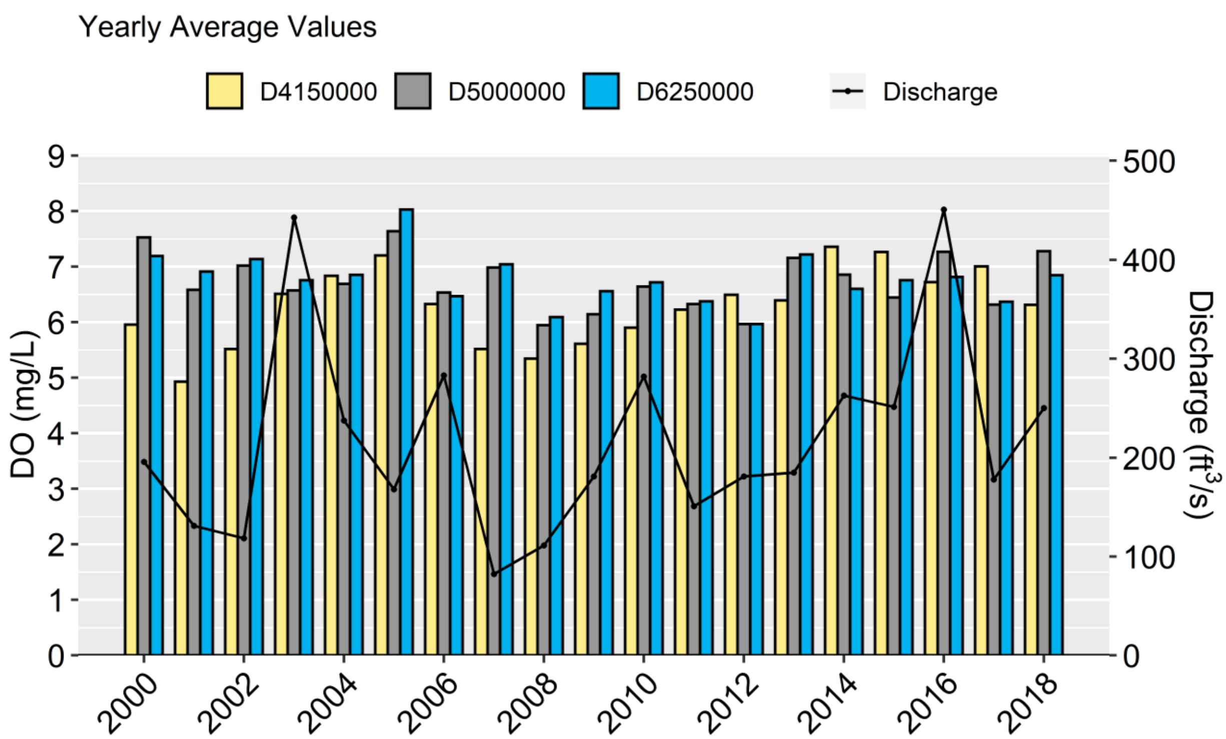


*Figure 2-13 Instantaneous Dissolve Oxygen Measurements Depth Profiles from Upper Chowan Station (D0010000) with Red Bars Indicating Values Below 4 mg/L at a Particular Depth.*

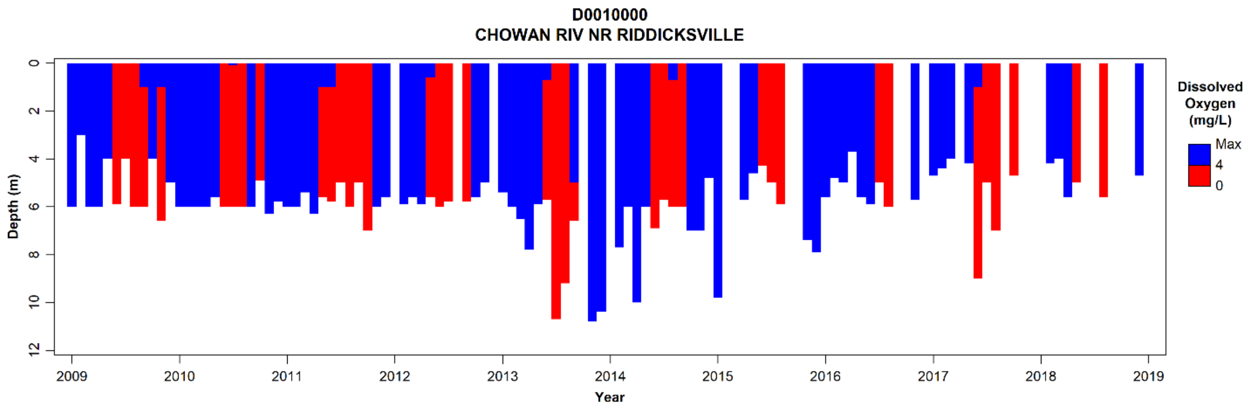



*Figure 2-14 Instantaneous Dissolve Oxygen Measurements Depth Profiles from Upper Chowan Station (D6250000) with Red Bars Indicating Values Below 4 mg/L at a Particular Depth.*

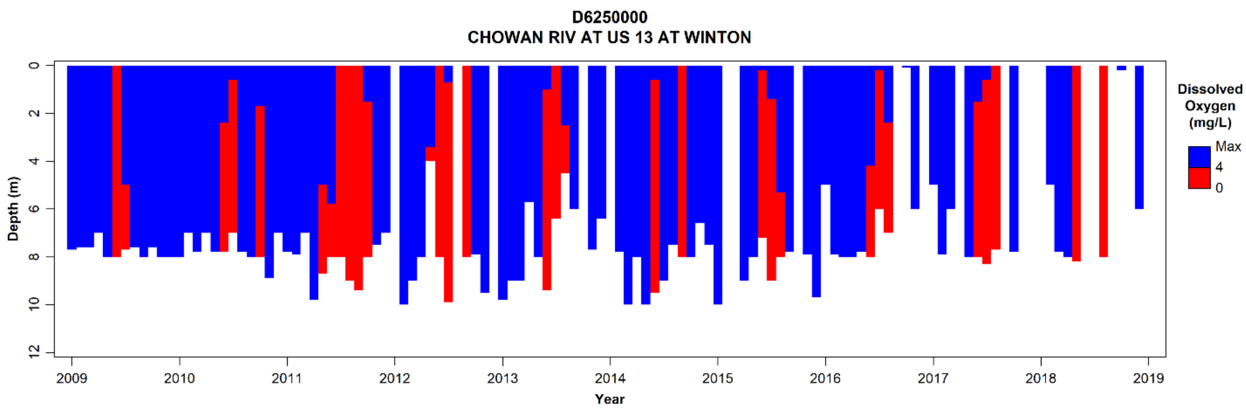



*Figure 2-15 Instantaneous Dissolve Oxygen Measurements Depth Profiles from Middle Chowan Station (D8356200) with Red Bars Indicating Values Below 4 mg/L at a Particular Depth.*

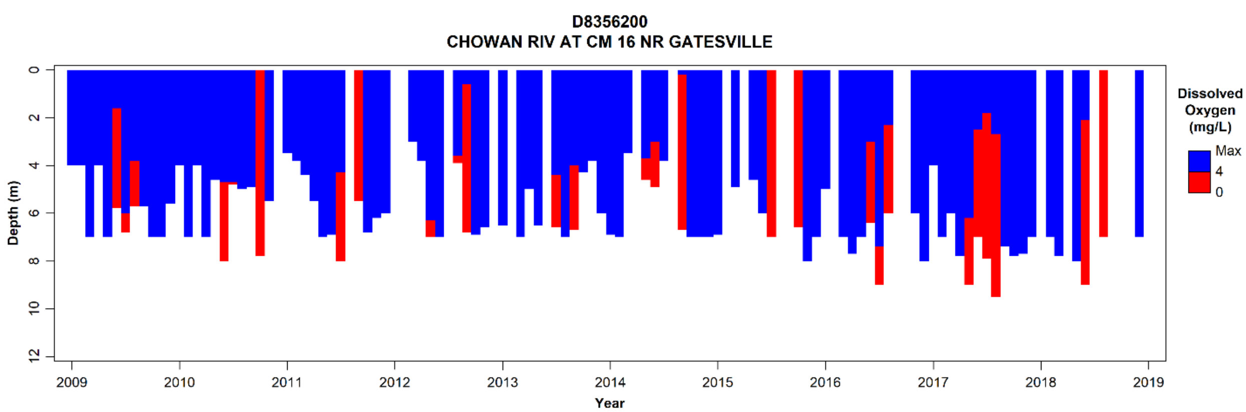


*Figure 2-16 Instantaneous Dissolve Oxygen Measurements Depth Profiles from Lower Chowan Station (D8950000) with Red Bars Indicating Values Below 4 mg/L at a Particular Depth.*

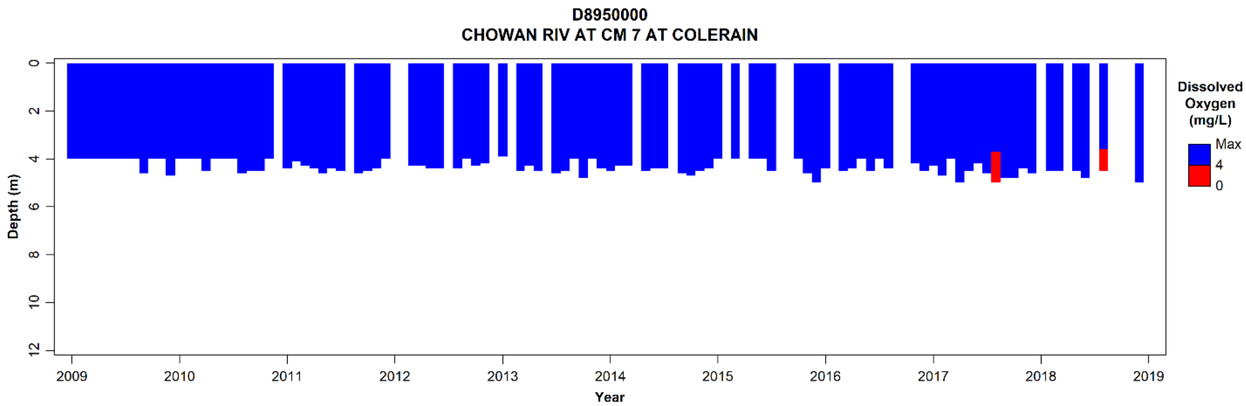
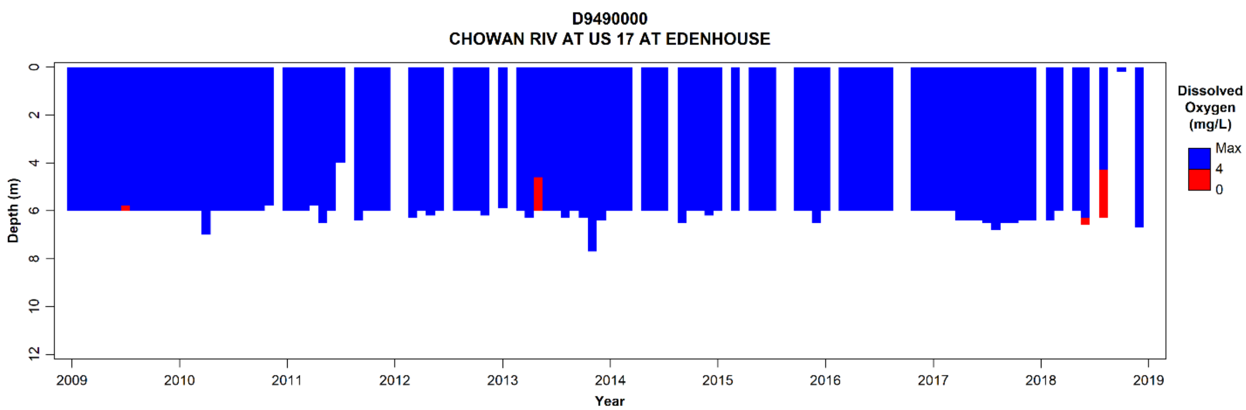



*Figure 2-17 Instantaneous Dissolve Oxygen Measurements Depth Profiles from Lower Chowan Station (D9490000) with Red Bars Indicating Values Below 4 mg/L at a Particular Depth.*




### 2.6.4 Fecal Coliform Bacteria

The fecal coliform bacteria standard for freshwater streams is not to exceed the geometric mean of 200 colonies/100ml or 400 colonies/100ml in 20% of the samples where five samples have been taken in a 30-day period (5-in-30). Only results from a 5-in-30 study are used to determine if the stream is impaired (exceeding criteria) or supporting (meeting criteria). Waters with a classification of B (primary recreation) will receive priority for 5-in-30 studies. Other waterbodies will be studied as resources permit. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with fecal material from humans or other warm-blooded animals. At the time of occurrence, the source water might have been contaminated by pathogens or disease producing bacteria or viruses that can also exist in fecal material. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to the water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste. Note the fecal coliform results are qualified due to the time required to transport the samples for analysis which is greater than the hold time, so the following results should be viewed as screening values.

Between 2000 and 2018, the annual geometric mean fecal coliform levels in the Blackwater (D0001800) river are often relatively higher than the Nottoway (D0000050) with the exception of 2017 and 2018. The Nottoway and Blackwater rivers come together to form the Chowan River which has annual geometric means which appear as a combination of the two rivers, but many years have values below or above both VA rivers which could have resulted from local influences (Figure 2-18). The annual geometric mean in the Chowan River (D6250000) remains relatively low compared to Potecasi Creek (D4150000) (Figure 2-19 and Figure 2-20). Potecasi Creek has annual geometric means which are consistently high relative to other Chowan River basin stations. Elevated fecal coliform and turbidity values collected from the ambient monitoring station on Potecasi Creek (D4150000) often occur when precipitation occurs which could indicate nonpoint source pollution contributions. Potecasi Creek is a Class C water which means this river is suitable for secondary recreation. Continued monitoring is necessary to ensure this Class C stream does not degrade and violate the freshwater standard. The Meherrin and Chowan Rivers appear to have the assimilation capacity to prevent the elevated fecal coliform levels from Potecasi Creek from impacting the water quality. This is observed in the Chowan River station D6250000 as a majority of the annual geometric means consistently decline following the contributions from the Meherrin River (D5000000) and Potecasi Creek (D4150000) (Figure 2-19).

*Figure 2-18 Annual Geometric Mean Fecal Coliform Readings from the Nottoway (D0000050), Blackwater (D0001800) and Chowan (D0010000) Rivers Discharge from the Nottoway River (USGS Gage 02047000).*

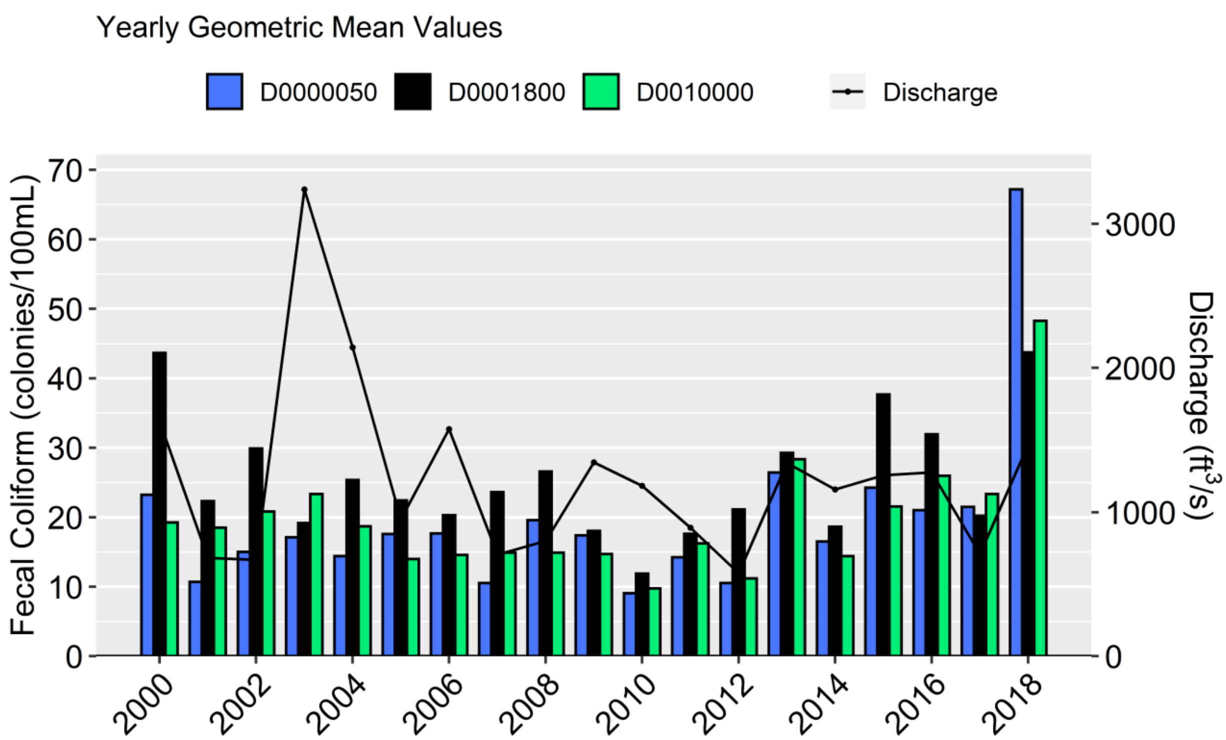


*Figure 2-19 Annual Geometric Mean Fecal Coliform Readings from the Mainstem Chowan River Stations with the Discharge from the Nottoway River (USGS Gage 02047000).*

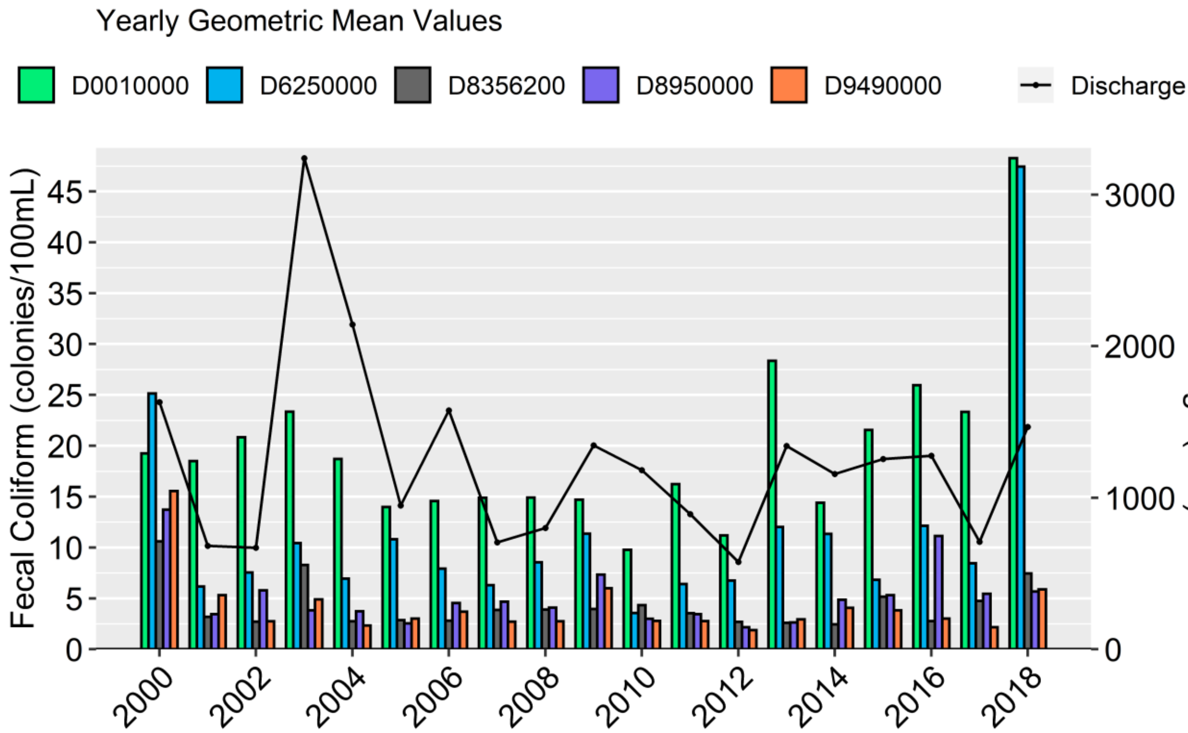
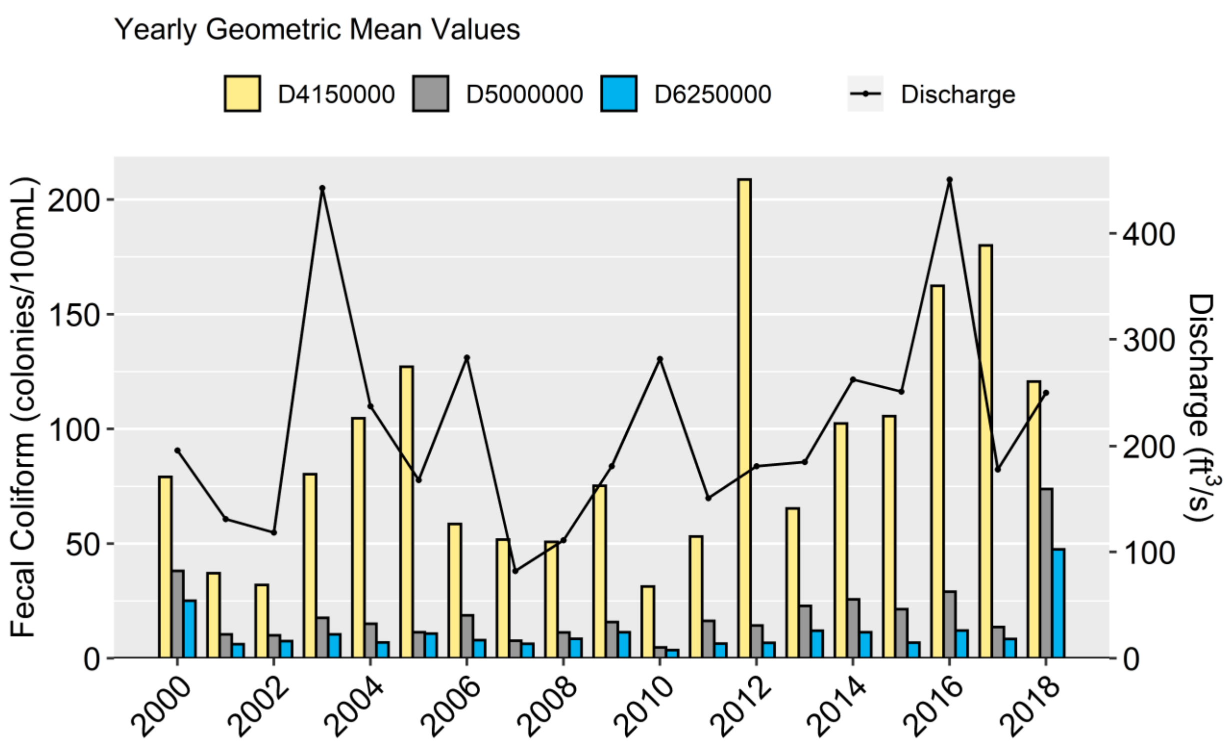



*Figure 2-20 Annual Geometric Mean Fecal Coliform Readings from Potecasi Creek (D4150000), Meherrin River (D5000000), Chowan River (D6250000) with the Discharge from the Potecasi Creek (USGS Gage 02053200).*



### 2.6.5 Specific Conductance and Salinity

Specific conductance, also referred to as specific conductivity or conductivity, is a measure of the ability of water to pass an electrical current. Higher specific conductance values can be an indicator of pollutants associated with discharge of chlorides, phosphates, nitrates, and other inorganic dissolved solids. There is no standard for specific conductance in NC. Specific conductance is similar to salinity. Salinity is a measure of the amount of dissolved salts in a waterbody.

The Blackwater River (D0001800) consistently displays higher annual mean specific conductance compared to the Nottoway River (D0000050), with the exception of a few years. The confluence of these two VA rivers results in the Chowan River (D0010000) annual mean specific conductance which often appears as an average of the two rivers (Figure 2-21). As the Chowan River is observed from the upper reaches (D0010000) until the furthest downstream station (D9490000), flushing from adjoining tributaries could be the cause for decreasing specific conductance and salinity while encroachment of saltwater could result in elevated specific conductance and salinity levels (Figure 2-22, Figure 2-24,Figure 2-25,Figure 2-26,Figure 2-27,Figure 2-28). The decreasing specific conductance observed in the middle Chowan River station D6250000 is probably a result of the Meherrin River joining the Chowan River; the Meherrin River has a lower specific conductance relative to the Chowan River (Figure 2-23). The lower Chowan River stations and Meherrin River station display possible influences from salt-water in 2002 and 2008 in the form of relatively high annual mean specific conductance possibly due to low freshwater flow (Figure 2-23).

*Figure 2-21 Annual Weighted Mean Specific Conductance Readings from the Nottoway (D0000050), Blackwater (D0001800) and Chowan (D0010000) Rivers with the Discharge from the Nottoway River (USGS Gage 02047000).*

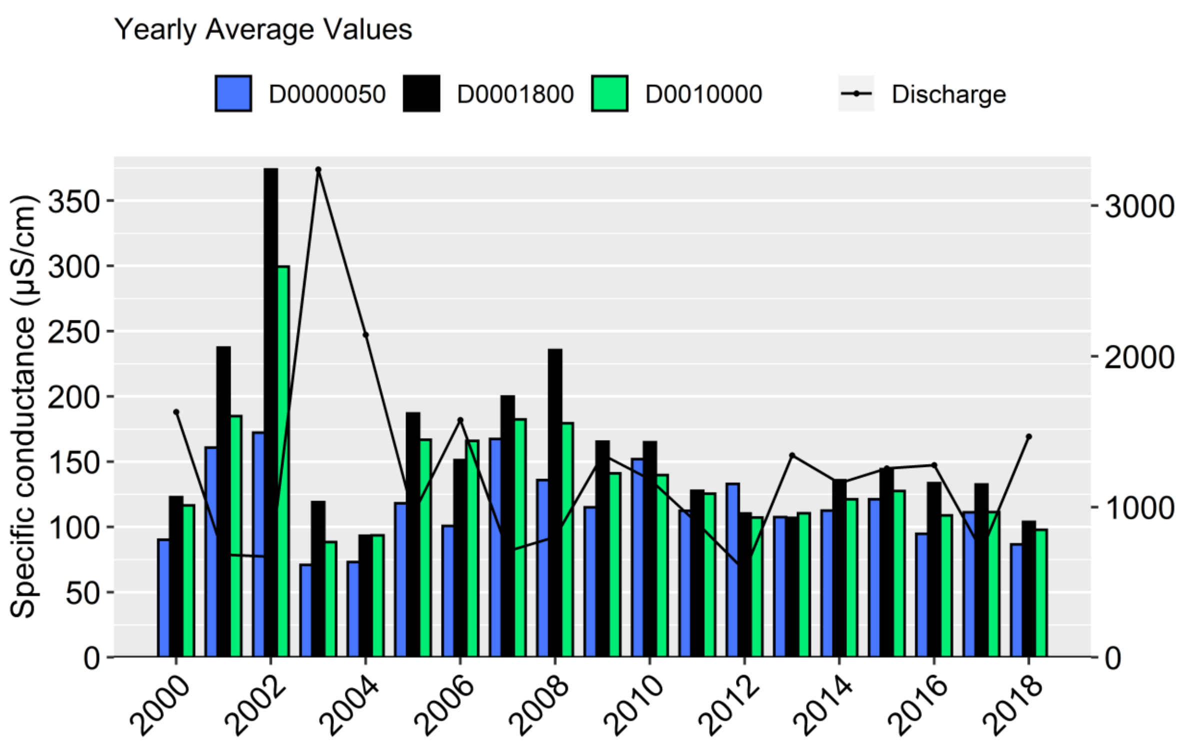


*Figure 2-22 Annual Weighted Mean Specific Conductance Readings from the Mainstem Chowan River Stations with the Discharge from the Nottoway River (USGS Gage 02047000).*

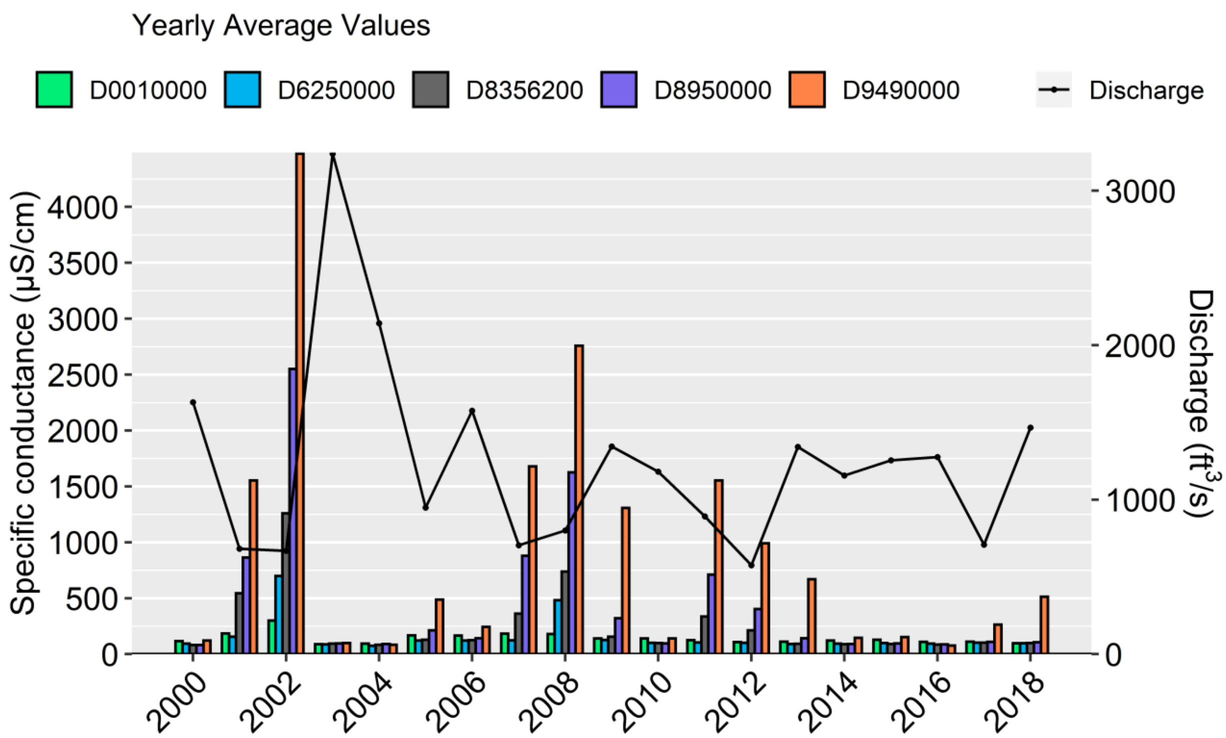



*Figure 2-23 Annual Weighted Mean Specific Conductance Readings from Potecasi Creek (D4150000), Meherrin River (D5000000), Chowan River (D6250000) with the Discharge from the Potecasi Creek (USGS Gage 02053200).*

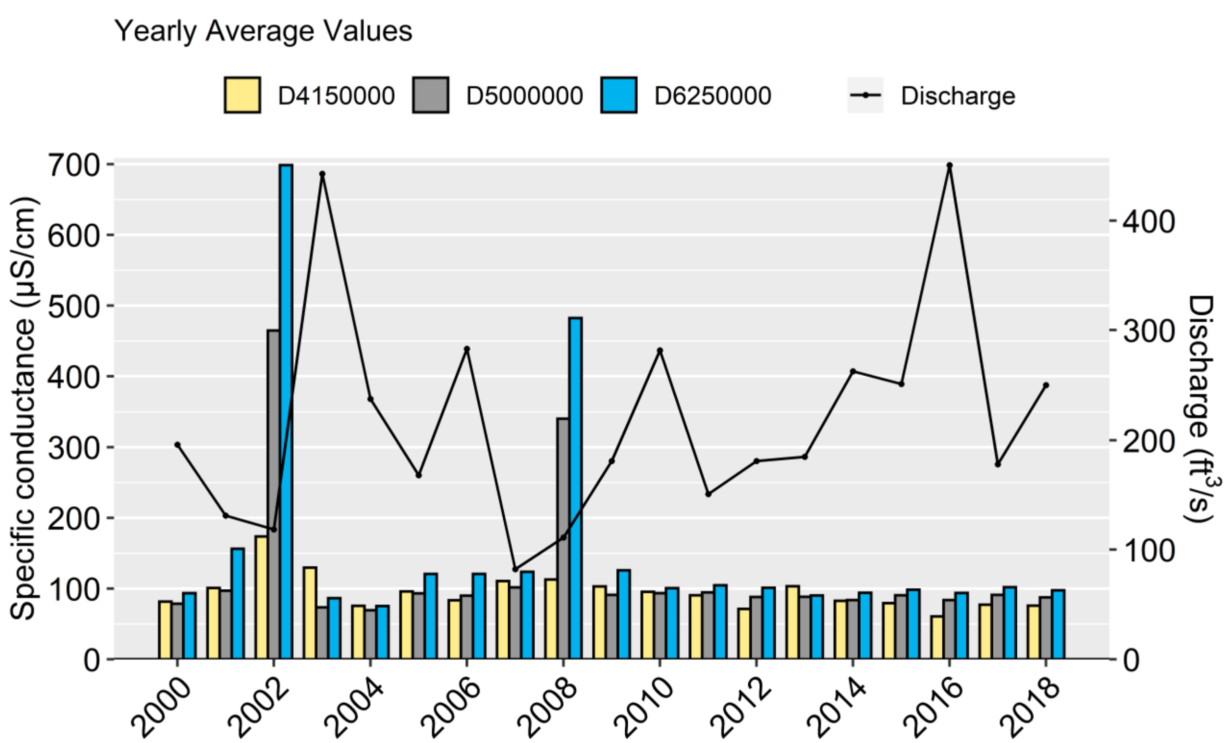


*Figure 2-24 Instantaneous Salinity Measurements Depth Profiles from Upper Chowan Station (D0010000).*

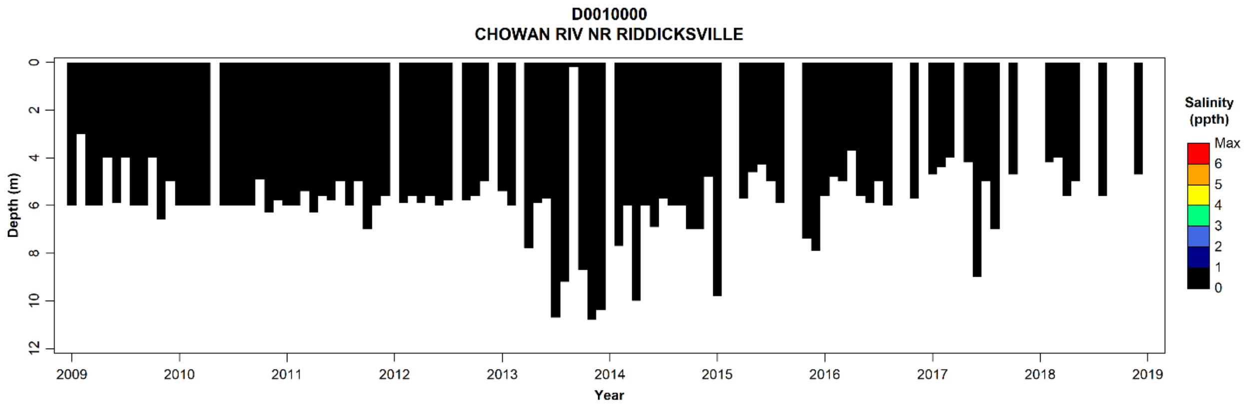



*Figure 2-25 Instantaneous Salinity Measurements Depth Profiles from Upper Chowan Station (D6250000).*

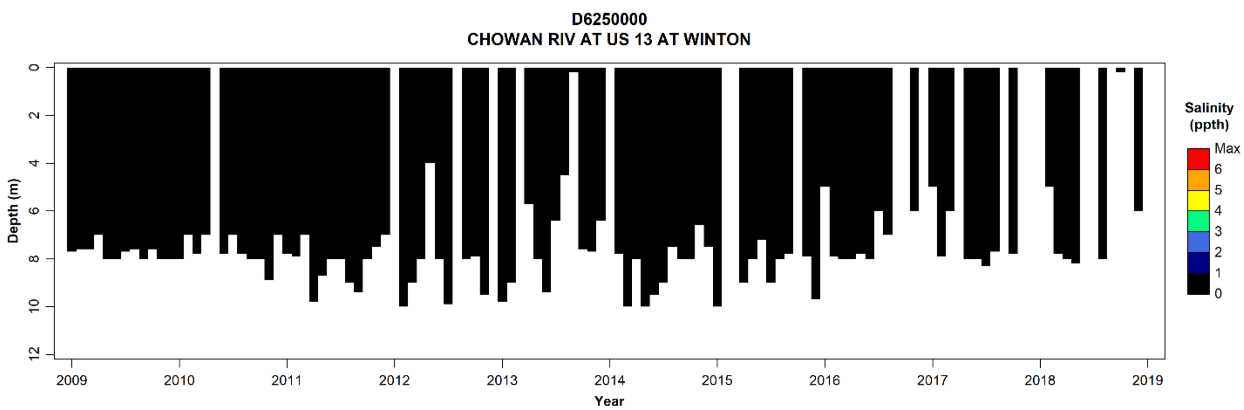



*Figure 2-26 Instantaneous Salinity Measurements Depth Profiles from Middle Chowan Station (D8356200).*

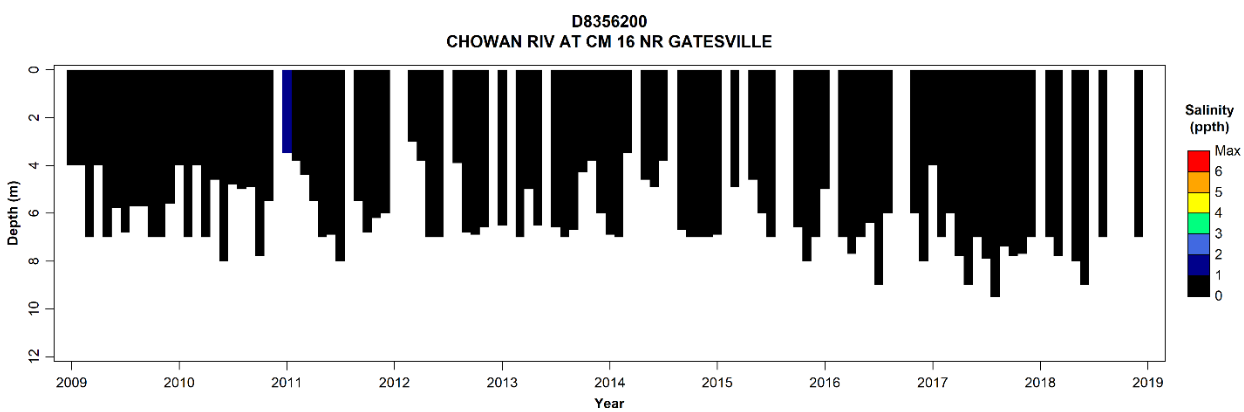


*Figure 2-27 Instantaneous Salinity Measurements Depth Profiles from Lower Chowan Station (D8950000).*

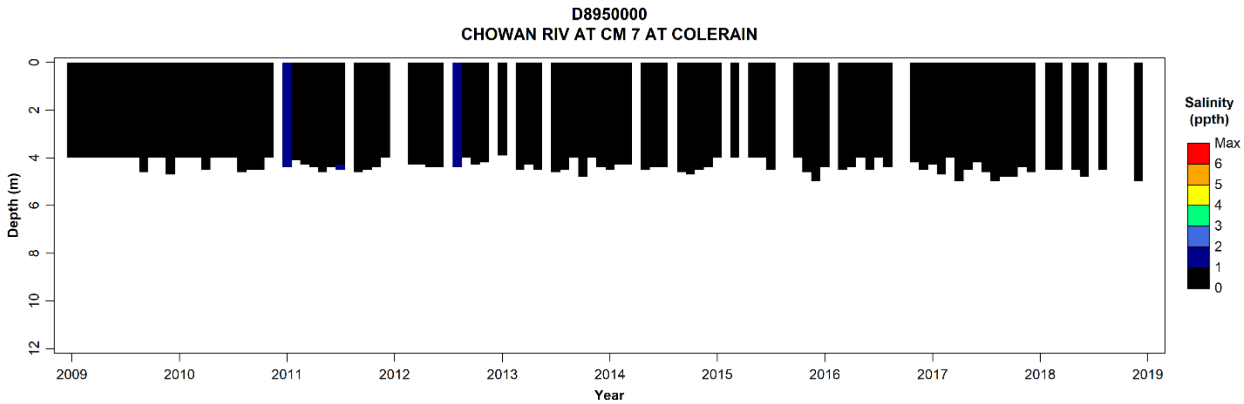
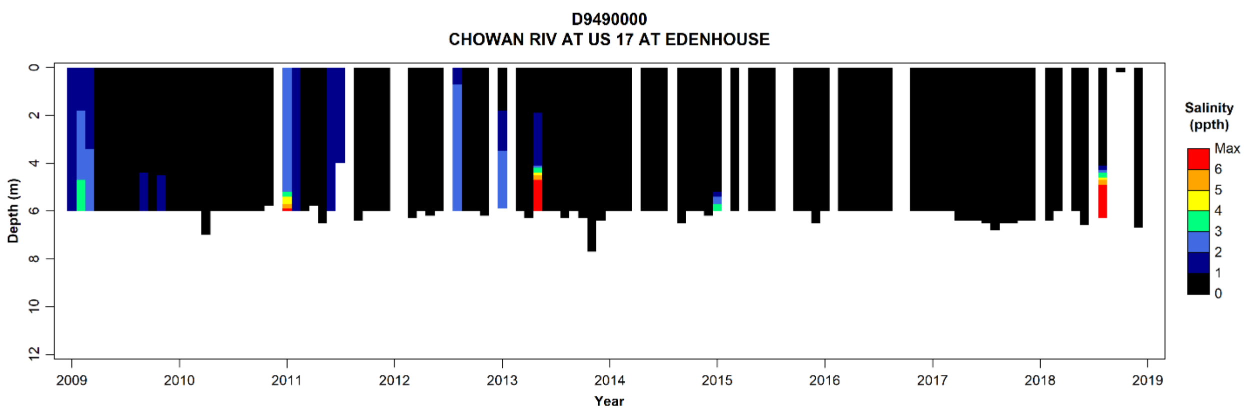



*Figure 2-28 Instantaneous Salinity Measurements Depth Profiles from Lower Chowan Station (D9490000).*




### 2.6.6 Water Temperature

All aquatic species require specific temperature ranges in order to be healthy and reproduce. An aquatic species becomes stressed when water temperatures exceed their preferred temperature range, often making them more susceptible to injury and disease. Trout, for example, prefer temperatures below 20°C (68°F) and cannot survive in the water reservoirs of the piedmont and coastal plain where temperatures can exceed 30°C (86°F). Changes to natural conditions or weather patterns can often change the ambient water temperature. For example, higher ambient water temperatures are expected during years with severe drought in areas where there is little shade. Higher ambient water temperatures can also be expected when air temperatures are high during summer months. Climatic conditions should also be taken into account and include extreme drought, hurricanes, flooding, and/or dam failures. North Carolina's water quality standards state that discharge from permitted facilities should not exceed the natural temperature of the receiving waterbody by more than 2.8°C (5.04°F).

The major contributors to changes in in-stream temperatures in the Chowan River and monitored tributaries are climate, air temperature, and canopy shading. The upper reaches of the Chowan River (D0010000) which includes the adjoining VA rivers the Blackwater (D0001800) and the Nottoway (D0000050) appear to have similar temperatures during many years (Figure 2-29). During many years the annual mean temperature in the Chowan River displays slight increases through the middle Chowan River station (D8356200) (Figure 2-30). The temperature profile then often declines until the furthest downstream station (D9490000), with the exception of a few years including the two most recent years 2017 and 2018 which showed increasing temperatures (Figure 2-30). The influence of the canopy cover is apparent when comparing the relatively lower stream temperatures in Potecasi Creek (D4150000) to the nearby Meherrin River (D5000000) and Chowan River (D6250000) (Figure 2-31).

*Figure 2-29 Annual Weighted Mean Temperature Readings from the Nottoway (D0000050), Blackwater (D0001800) and Chowan (D0010000) Rivers with the Discharge from the Nottoway River (USGS Gage 02047000).*

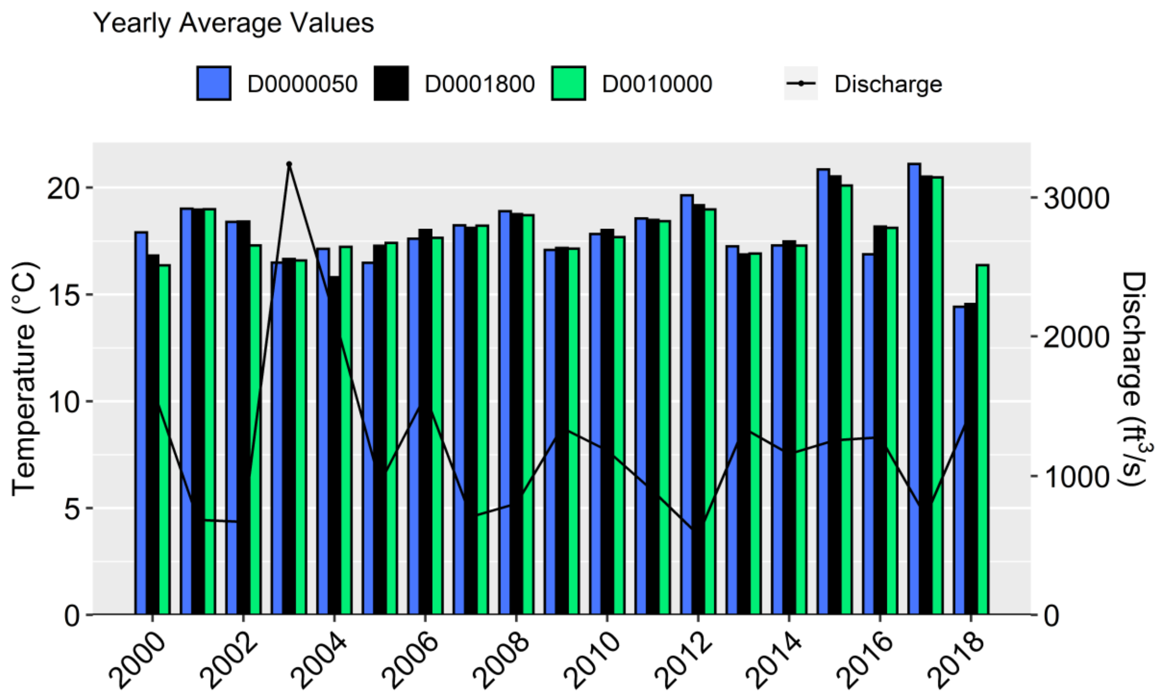


*Figure 2-30 Annual Weighted Mean Temperature Readings from the Mainstem Chowan River Stations with the Discharge from the Nottoway River (USGS Gage 02047000).*

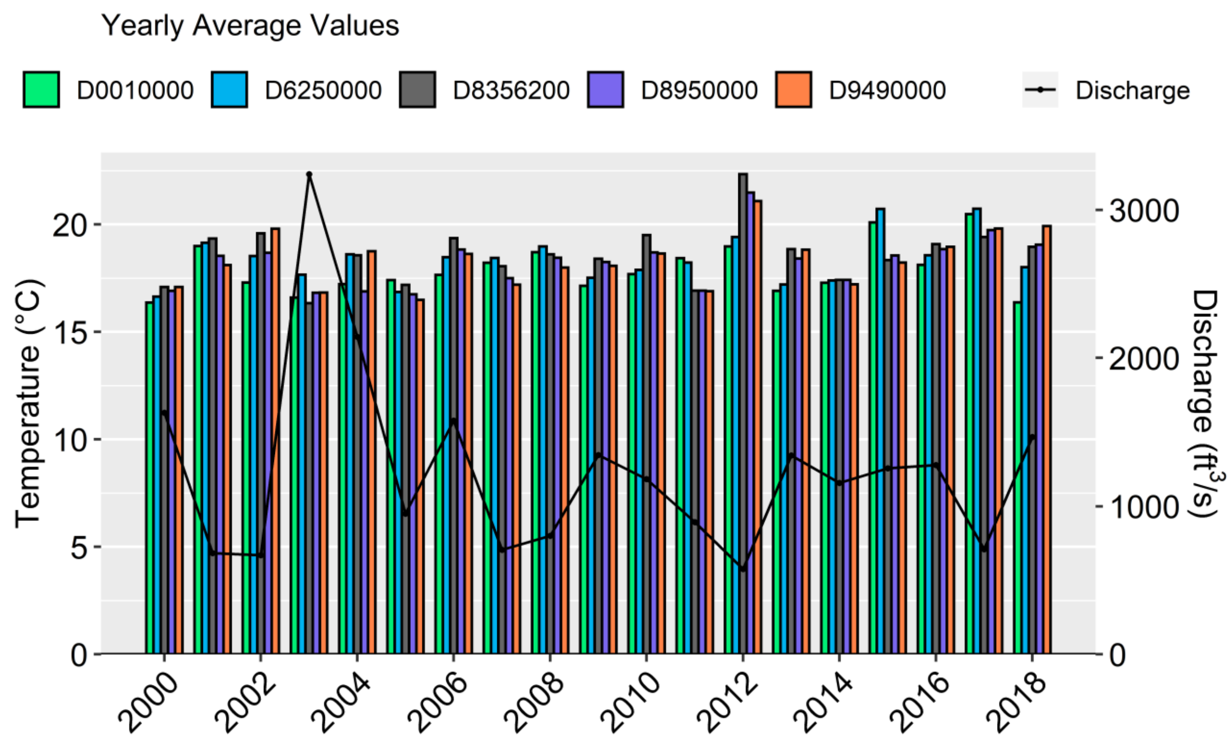
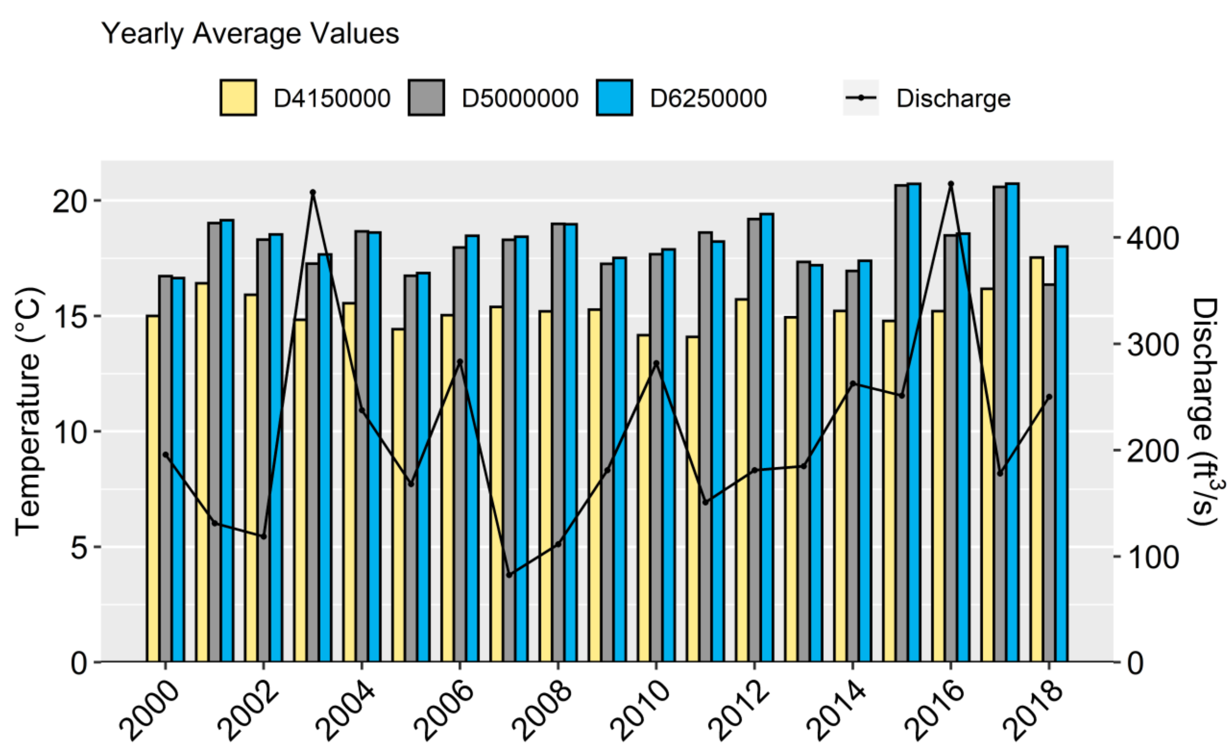



*Figure 2-31 Annual Weighted Mean Temperature Readings from Potecasi Creek (D4150000), Meherrin River (D5000000), Chowan River (D6250000) with the Discharge from the Potecasi Creek (USGS Gage 02053200).*



## 2.7 Lakes and Reservoirs

The WSS Intensive Survey Branch (ISB) collects and interprets biological, chemical, and physical data from NC's lakes for their Ambient Monitoring Program, Lake TMDL Studies, and other Special Studies/Intensive Surveys. The ISB monitors ambient lake stations on the same 5-year monitoring cycle as the biological sampling. In the Chowan River basin, two stations from Merchant Millpond were monitored in 2005, 2010 and 2015 (Table 2-5). The lake is sampled during the growing season, May through September. Merchants Millpond has been determined to be eutrophic, having high biological productivity, since it was first monitored by the division in 1981. Sampling methodology is described in further detail in ISB's Standard Operating Procedure.

*Table 2-5 Water Quality Data for Merchants Millpond, Chowan River Basin (NCDEQ, 2015).*

| | SURFACE PHYSICAL DATA | | | | | | | PHOTIC ZONE DATA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Sampling Station | DO mg/L | Temp Water C | pH s.u. | Cond. µmhos/cm | Secchi Depth meters | Percent SAT | TP mg/L | TKN mg/L | NH3 mg/L | NOx mg/L | TN mg/L | TON mg/L | TIN mg/L | Chla µg/L | Total Solids mg/L | Total Suspended Solids mg/L | Turbidity NTU |
| May 13, 2015 | CHO0153A | 5.0 | 27.5 | 6.3 | 89 | 0.4 | 63.3% | 0.20 | 1.10 | 0.020 | 0.040 | 1.14 | 1.08 | 0.06 | 22.0 | 104 | | 3.6 |
| May 13, 2015 | CHO0154A | 6.6 | 25.2 | 6.5 | 86 | 0.7 | 80.2% | 0.28 | 1.60 | 0.020 | 0.050 | 1.65 | 1.58 | 0.07 | 14.0 | 148 | 72.0 | 18.0 |
| August 10, 2015 | CHO0153A | 2.5 | 22.8 | 6.0 | 77 | 0.7 | 29.0% | 0.17 | 0.84 | 0.030 | <0.02 | 0.85 | 0.81 | 0.040 | 5.4 | 98 | <6.2 | 6.0 |
| August 10, 2015 | CHO0154A | 2.3 | 24.3 | 5.9 | 78 | 0.8 | 27.5% | 0.17 | 0.88 | 0.020 | <0.02 | 0.89 | 0.86 | 0.03 | 8.8 | 101 | 8.2 | 5.0 |

## 2.8 Ground Water Quality

In the absence of routine ambient ground water quality monitoring, the best available indicators in the Chowan River basin come from the routine sampling of newly-constructed private drinking water wells. Under the statewide private well testing program administered by Department of Health and Human Services (DHHS) and local health departments, all new private drinking water wells are sampled by local health departments and analyzed for a standardized list of chemical constituents by the State Laboratory of Public Health in DHHS. In addition to their value to individual well users, these samples are the most abundant source of data on the status of ground water quality across the state. The private well sample water quality results are housed on the North Carolina State Laboratory website (https://celr.ncpublichealth.com/environmental). When a constituent within an individual well exceeds drinking water health standards or groundwater standards established by the Department of Environmental Quality (DEQ) for one or more constituents, the local health department, along with DHHS, provides the well owner with information about the constituents identified in the ground water sample and what steps may be necessary to protect the well users' health. More information can be found on DHHS's website or by contacting your local health department.

Groundwater Management Branch (GWMB) staff collect groundwater quality data throughout the state. Most of the groundwater quality data being collected is from the Division of Water Resources (DWR) Monitoring Well Network (MWN). The DWR MWN consists of 685 groundwater wells at 228 sites across North Carolina. These wells range in age from 50+ years to less than a year old. A typical well site in the Coastal Plain may have several wells, each screened in one of the different aquifers at that particular location, while most well sites in the Piedmont and Mountain regions of the state have only one well in the basement rock/saprolite aquifer system.

These wells are, in most cases, located in areas where influence by industry or other land-use practices on groundwater quality is unlikely. This, along with the MWN's broad geographic and geologic coverage, provides prime conditions and an excellent opportunity to conduct a detailed characterization of ambient, or background, groundwater quality from both deep and shallow aquifer systems throughout the state. Currently, a long-term sampling project is underway to collect water quality data from all wells in the network (map). More information about the groundwater monitoring effort can be found on the GWMB website. In addition to the MWN, the GWMB has developed a streamflow partition calculator combined with water quality analyses which could indicate if a source of pollution is derived from runoff or baseflow. The baseflow calculator is accessible through the GWMB website.

## 2.9 Atmospheric Deposition

The National Atmospheric Deposition Program (NADP) is a collaboration between federal, state, and local agencies. The NCDP precipitation chemistry network started in 1978 providing water quality information ($H^+$ as pH, conductance, calcium, magnesium, sodium, potassium, sulfate, nitrate, chloride, and ammonium) by collecting weekly samples. The NADP National Trends Network (NTN) calculates trends for atmospheric deposition using annual mean concentrations and depositions are characterized as meeting or not meeting the NADP's data completeness criteria for each 1-year period (Figure 2-32, Figure 2-33, Figure 2-34, and Figure 2-35). The trend line is a smoothed three-year moving average with a one-year time step. The line is only displayed where the minimum data completeness criteria is met for the three-year period. The trends below are data from Site 03 of the NADP NTN. An interactive map with all the NADP sites can be found on their website.

*Figure 2-32 Trends for Atmospheric Deposition Using Annual Weighted Mean Ammonium Concentrations at NTN Site NC03 (NADP, 2020)*

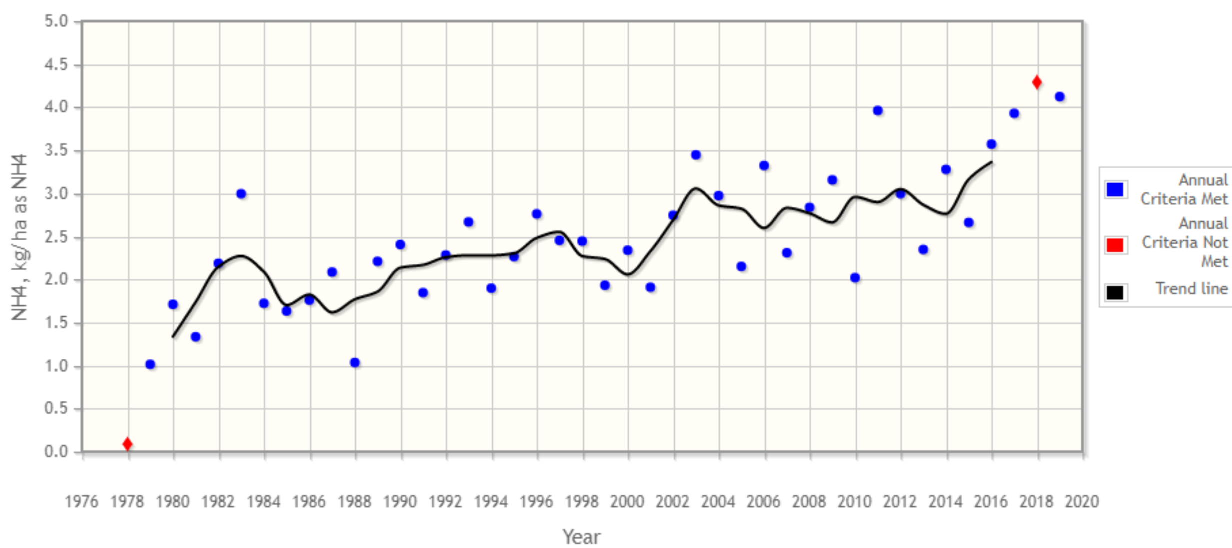


*Figure 2-33 Trends for Atmospheric Deposition Using Annual Weighted Mean Nitrate Concentrations at NTN Site NC03 (NADP, 2020)*

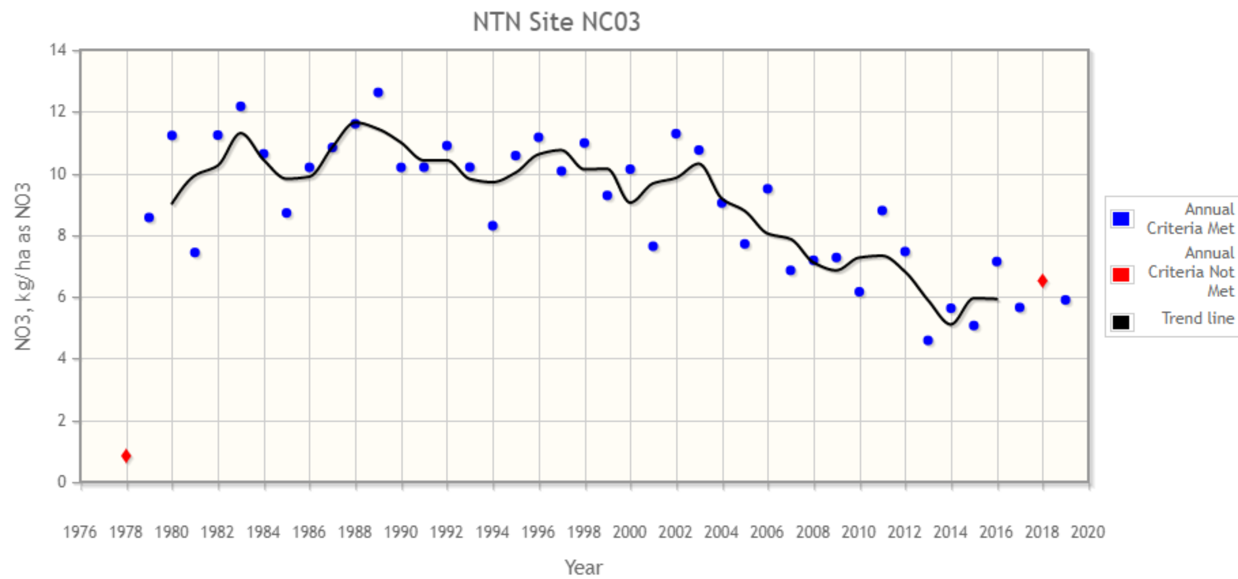



*Figure 2-34 Trends for Atmospheric Deposition Using Annual Weighted Mean Total Nitrogen Concentrations at NTN Site NC03 (NADP, 2020)*

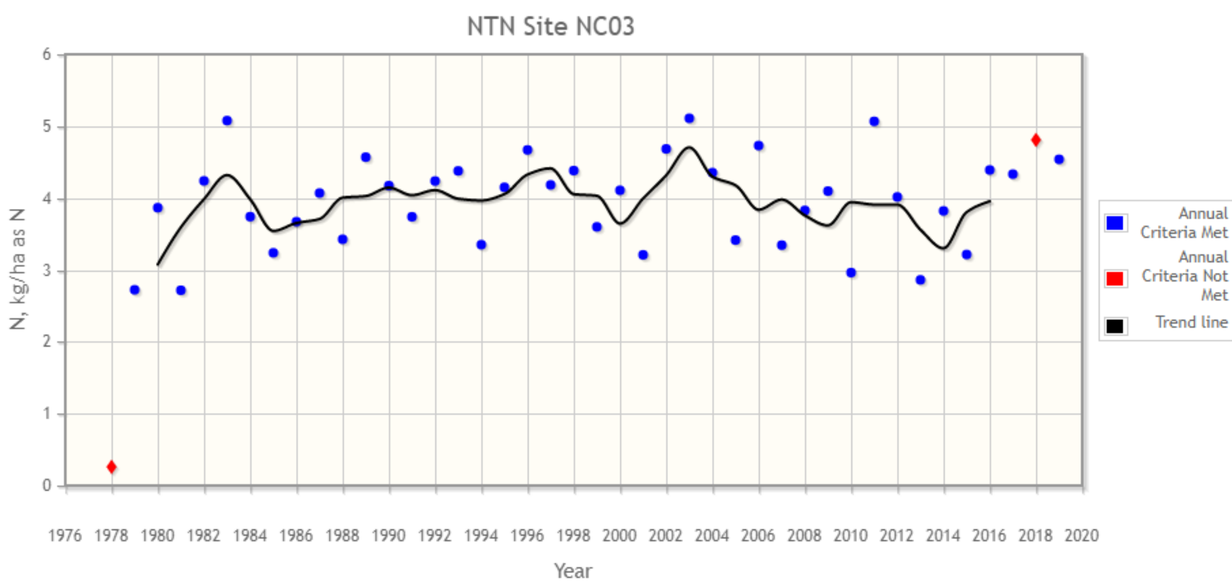
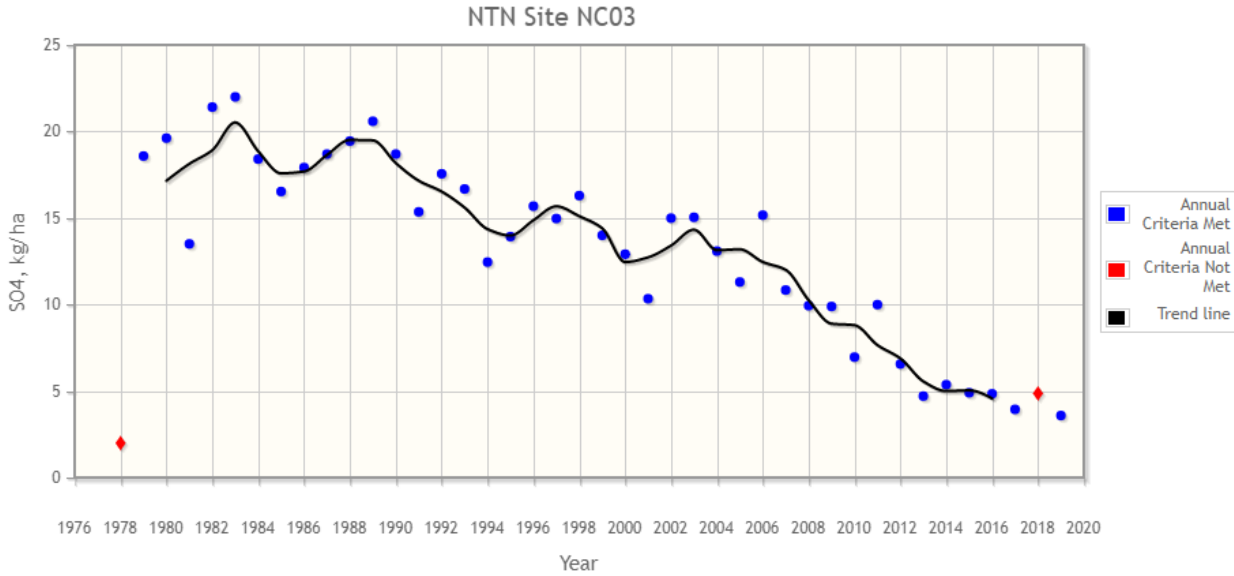


*Figure 2-35 Trends for Atmospheric Deposition Using Annual Weighted Mean Sulfate Concentrations at NTN Site NC03 (NADP, 2020)*



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National Atmospheric Deposition Program, 2020. Site NC03 Bertie, NC Accessed: http://nadp.slh.wisc.edu/data/ntn/plots/ntntrends.html?siteID=NC03